

University of Helsinki, Faculty of Medicine
Department of Public Health

THE HEALTH OF THE FINNISH SAMI IN LIGHT OF MORTALITY AND CANCER PATTERN

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ACADEMIC DISSERTATION

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ABBREVIATIONS

AH	Arctic haze
AMAP/HH	Arctic Monitoring and Assessment Program/Human Health subprogram
Bq	Becquerel (unit of radioactivity)
Ca	Calcium
Cd	Cadmium
Ci	Curie (unit of radioactivity)
95% CI	95% confidence interval
Cs	Caesium
Cu	Copper
CVD	Cardiovascular disease
E%	Energy% (per cent of energy of a food stuff of the total energy)
EVIRA	Elintarviketurvallisuusvirasto EVIRA, Finnish Food Safety EVIRA
FCR	Finnish Cancer Registry
FD	Food diary method
FQ	Food frequency questionnaire method
Gy	Gray. Unit of the absorbed amount of radioactivity.
μGy	Mikrogray = 10^{-6} Gy
Hg	Mercury
IARC	International Agency for Research on Cancer (WHO)
IASC	International Arctic Science Committee
IBP/HA	International Biological Program/Human Adaptability- section
ICD	International Classification of Diseases
ICD-O-3	International Classification of Diseases for Oncology
IHD	Ischaemic heart disease
Kcal	1000 calories
Kela	Kansaneläkelaitos (The Social Insurance Institution of Finland)
OHD	Other heart disease
OR	Odds ratio
pCi	Picocurie = Ci x 10^{-12}
Pb	Lead
PHN	Public health nurse

PCB	Polychlorinated biphenyl
Po	Polonium
P/S ratio	Fat ratio of polyunsaturated and saturated fats
Pu	Plutonium
RL	Region of the Hospital District of Lapland
RKTL	Riista- ja kalatalouden tutkimuslaitos (Finnish Game and Fisheries Research Institute)
RO	Region Oulu, Region of University Hospital of Oulu
Se	Selenium
SIR	Standardized incidence ratio
SMR	Standardized mortality ratio
Sr	Strontium
Standard population	The population, which is used as reference when the SIRs and SMRs are calculated (also called reference population)
UCD	Underlying cause of death
Zn	Zinc
WHO	World Health Organization (United Nations)

Explanations:

Municipality	The local administrative unit in Finland, which is responsible for the health services of its inhabitants. Sometimes the word “commune” is used in the same meaning.
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ABSTRACT

Objectives. The Sami are regarded as indigenous people of Scandinavia and northwest Russia. Their traditional dwelling zone consists of the most northern parts of those countries. The Sami consist of rather small groups that have been living in isolation for a long time in harsh circumstances. Because there was not much data about the health and diseases of these Finnish ethnic minorities, the health of the Sami is the object of this dissertation, approached in terms of cause specific mortality, cancer incidence and the cancer patient survival.

Material and methods. All persons living in the two northern municipalities of Finland (Inari and Utsjoki) on 31st December 1978 were identified from the National Population Register. The Sami cohort was extracted from that by using the grouping of Sami of the International Biological Program, Human Health Adaptability-study. Dates of death and emigration of the cohort members were obtained from the Population Register. Follow-up for cancer through the files of the population-based countrywide Finnish Cancer Registry was done using the personal identification code as the key. The first period of the follow-up for mortality and cancer started on 1st January 1979 and ended at death or on 31st December 2005 (Study I, mortality), on 31st December 1998 (Study II, cancer), and on 31st December 2009 (Study IV, survival of cancer patients). The second period started on 1st January 2006 and ended 31st December 2010 (Study I) and Study II started on 1st January 1999, and ended on 31st December 2010. In Study III, a comparison of several cancer studies from Finland, Sweden and Norway from different time periods between the years 1961–2006 was made.

A person representing at least 75 per cent of any ethnic group of Sami was classified as Sami. A non-Sami is a person without any Sami ethnicity, and the remaining persons were classified into the mixed group. The Sami group was divided into subcategories of North Sami, Inari Sami and Skolt Sami with the same principle: to be classified in a specific Sami subgroup, a person had to represent at least 75 per cent of this type of the three specific Sami ethnicity.

In Study III, in Sweden and Norway the defining of Sami people for epidemiological studies has been different. In Sweden, all possible registers have been combined to find the Sami, and in Norway, the defining is concentrated to the Sami counties and the interview. In all countries, the Sami have mixed more or less with the main population, and therefore the Finnish cohort was recalculated for Study III. The Finnish cohort in that study has included all Sami with 1–100% of Saminess.

Results. The overall mortality among the Finnish Sami in the first time period studied, 1979–1987, was statistically significantly lower than the mortality of the general population of Finland, the standardized mortality ratio (SMR) being 0.86 (95% confidence interval (CI) 0.75–0.99), while since 1988 it was not different from that of the general population, which in 1988–2010 was 1.04 (95% CI 0.95–1.13). The cancer mortality of the Sami in 1979–2010 was low, with a SMR of 0.83 (0.70–0.98). The SMR for accidents among men in 1979–2010 was 1.88 (1.36–2.52) with a 17-fold elevated mortality from “other land transport accidents”, which in Lapland mainly refers to snowmobile accidents. The SMR of the water transport accidents was elevated by 8-fold. The suicide mortality of Sami men was significantly elevated, SMR 1.78 (1.14–2.65). The total mortality of Skolt Sami was elevated, SMR 1.23 (1.04–1.44), and that of the North and Inari Sami was a little below 1.

The cancer incidences of the North and Inari Sami during the time period 1979–2010 were significantly lower than in the average Finnish population. For the North Sami, the standardized incidence ratio, SIR was 0.68 (95% CI 0.55–0.82) and for the Inari Sami 0.57 (0.43–0.74). The SIR for Skolt Sami was 0.96 (0.71–1.27) because of the high SIR for stomach cancer, which in 1979–1998 was 4.00 (1.61–8.24). It was decreased in 1999–2010, SMR 1.67 (0.04–9.29). Common cancers among the Finnish main population like cancers of the prostate, breast and skin, are especially rare among the Finnish Sami. The SIRs and the SMRs of cancers among the Finnish Sami are rather similar to those of the Swedish and Norwegian Sami. However, the Swedish Sami still had an increased SIR for stomach cancer. The SIR for all sites of Swedish Sami women was close to 1. The survival of the Finnish Sami cancer patients was the same as that of the comparable cancer patients in the general population. The effect of radioactive or chemical pollution could not be seen in the mortality or cancer incidence results.

Conclusions. The disease mortality among the Sami was decreased in the 1980s, but then reached the level of the average population. Cancer incidence among the North Sami and Inari Sami has been low, while among the Skolt Sami it was not differing from the incidence of Finnish population, because of high stomach cancer incidence. The results for the Swedish and Norwegian Sami were mostly similar. The harsh environment and the Sami living habits seem to have been good for health, but the possible effect of genetic features cannot be excluded. The cancer survival of the Sami cancer patients is not different from that of the non-Sami cancer patients in the same area or from the cancer patients generally in Finland. Hence, despite the long distances in Northern Finland, the diagnostics and treatment of cancer in the Sami region appears to be similar as in other parts of Finland.

The living habits and environment of the Sami have changed, and hence also the mortality and cancer morbidity are nowadays more like that of the majority of

Finnish and other western populations. They have gone through an epidemiological transition, different subgroups in different times. The traditional Sami living has been a good example of a healthy way of living, except for the risk-taking of Sami men. From the point of health, it seems to be important to which population and to which era a person is born.

1 INTRODUCTION

The Sami (earlier called Lapps) consist of small ethnic subgroups, which have been living as minorities in northern parts of Finland, Norway, Sweden and Russia. From the medical point of view, the Sami are an interesting group of ethnic minorities that have had their own culture with special living habits almost until these days. They have survived in a severe environment during generations. The health risks that they had earlier have been changing already for several decades. How that is seen in their health and diseases is the aim of this study. It is postulated that the Sami groups have been in different phases of epidemiologic transition when they started to move from isolated living to modern society with its negative and positive features.

The special features of the Sami Homeland that are connected to the northern location (cold, and light with their seasonal variation) have always been the same, but in beginning of 1970s the radioactive and in the beginning of 1980s the chemical pollution from Kola Peninsula brought new fears. Within that framework, in addition to the Sami traditional environment, the polluted environment is also surveyed from the literature, as well as the living habits and health risks. The diseases of the Sami are studied from the literature and using cause specific mortality (Study I). Cancer is studied closer and compared to the Swedish and Norwegian Sami cancer statistics (Study II, Study III), and finally the survival of Sami cancer patients (Study IV) is compared to other cancer patients in the same area and in the whole of Finland. The results of mortality and cancer are updated until 2010, hence with these new results the whole period of 1979–2010 is examined.

The amount of published health studies concerning the Sami and other arctic peoples have increased after the founding of the International Journal of Circumpolar Health in the beginning of 1970s. There is, however, a problem in Sami studies in the Nordic countries because of the lack of a Sami register, which could be used for scientific research (Lund et al 2008). In the International Biological Program, section, Human Adaptability (IBP/HA) studies in Inari, all Sami persons who were involved, were interviewed and their genealogy was studied (Eriksson et al 1975, von Bonsdorff et al 1974). In spite of the wide range of studies, health and common diseases, except arterial hypertension were not studied. However those studies have given a good background for this study, which started in the middle of 1970s, and could utilize the cohort formed in the IBP/HA field studies in 1966–1970. In this study, the Sami of Inari and Utsjoki are examined. The Sami in Sodankylä and Enontekiö are excluded.

2 LITERATURE REVIEW

2.1 THE SAMI

The traditional Sami area extends from the northern parts of the Kola Peninsula in Russia to the north of Finland, Norway and Sweden and over both sides of the Kohlen mountains towards the south to Trondheim in Norway and Idre in Sweden (on 62° latitude) (Figure 1). In the Nordic countries, many Sami have moved outside the Sami area, especially to the capitals of their countries. The total amount of Sami is estimated to be 75,000–100,000. Most are living in Norway, 50,000–65,000. In Sweden there are about 20,000–40,000 Sami (Sami in Sweden 2014) and in Finland 9,000 (Sami Parliament 2011). In Kola Peninsula, Russia, there are, 1,000–2,000 Sami (Kaminsky 1996, Rantala 2001). These Russian Sami consist of Kildin Sami, Akkala Sami, Ter Sami and some Skolt Sami. In all countries, there has been considerable acculturation among the Sami. The Finnish Sami consist of three different Sami subgroups, North Sami, Inari Sami and Skolt Sami, who have mixed with each other and Finns.

2.1.1 THE ROOTS AND HISTORY OF THE SAMI

About 2000 years ago the Sami settlement covered almost all of Finland, the Northern half of Norway and Sweden and Kola Peninsula and Karelia in Russia. Over the centuries, the Sami settlement has retreated steadily more and more to the north in Finland and Karelia, and further to the southwest in Scandinavia. The maps in Figure 1 show the Sami settlement area firstly some 2000 years ago, and then in 1949. In figure 2 the dates (years) indicate when people knew that Sami last lived at different sites. The southern border lines of the Sami population are seen in 13th century, 16th century and in 19th century (Itkonen 1948, Saamelaisiain komitean mietintö 1952).

The population genetic studies, which started in the 1960s, showed that the Sami are genetically different from the Finnish population, other Europeans and the Sami subgroups also from each other (Eriksson 1979). In the phylogenetic family tree of Cavalli-Sforza (1994), the Sami are in the outermost branch. Their genetic distance from other Europeans is long. When the origin of the Sami has been studied by the so-called paternal- and maternal lines, they are regarded as

2.1.2 DEFINITION, HOME AREA AND THE NUMBER OF THE SAMI

In Finland, the definition of a North Sami and Inari Sami is laid down in the Act on the Sami Parliament (974/1995). The definition was earlier based only on the Sami language, but now the descendants of the Sami are also taken into consideration, although they do not know the language. According to the definition, a Sami is a person who considers him- or herself a Sami, provided that this person has learned Sami as his/her first language, or who has at least one parent or grandparent whose first language is Sami, or who is a descendant of such a person called a Mountain Lapp, Forest- or Fisher Lapp or who is the descendant of persons in cadastres, tax roll- or census registers, or if he/she or at least one of his/her parents has been or could have been listed as eligible to vote in the elections of the Sami delegation or the Sami Parliament. Inari Sami have lived only in Finland, whereas the North Sami have their tradition with the Sami from other Nordic countries. The Skolts migrated after the Second World War from the municipality of Petsamo, which now belongs to Russia (Lewin et al 1971). The definition of a Skolt Sami is laid down in the Skolt Act from 1995, and it is in principle the same as the definition of the other Sami (253/1995).

In this study, the names North Sami and Inari Sami are used. North Sami are also called Mountain Sami, Reindeer Sami or Fell Sami. Inari Sami are also called Fisher Sami. Inari Sami means the original Fisher Sami who always lived in Inari, not the whole Sami population of the Inari municipality as it happens sometimes. All three Finnish Sami subgroups are living in the Inari municipality. In Utsjoki, Enontekiö and Sodankylä, the majority of Sami are North Sami.

The area designated as the Sami Homeland in the Act on Sami Parliament (974/1999) comprises the three northernmost municipalities of the country (Utsjoki, Inari and Enontekiö), and the area of the Lapland Reindeer Herding Cooperative in the municipality of Sodankylä (68° latitude). The width of the area is 35,000 km². That area is about the same as in figure 4, where the living areas of the Finnish Sami groups are located. Similar territories have not been legally designated in Norway and Sweden (Seurujärvi-Kari 2005).

The number of Sami has been estimated in 1948–1949, 1962, 1970, 1975, 1984 and from 1999 on the Sami Council has made its voting lists. In 1999, according to that list, 6% of the Sami were living in Enontekiö, 30% in Inari, 13% in Utsjoki, 6% in Sodankylä and 46% outside the Sami Homeland.

In 1948–49, the priests of the Sami municipalities reported the number of Sami in their parishes. There were 1509 North Sami, 543 Inari Sami and 394 Skolt Sami living on the Sami Home area. Outside the Sami area there were 83 persons (Saamelaisiain komitean mietintö 1952).

A detailed demographic study of the Sami was made in Finland in 1962 through

interviews (Nickul 1968). “All persons within the Sami area, who had among their parents or grandparents at least one person who had learned Sami language as his or her first language were considered to be Sami”. According to these definitions, 3843 persons were classified as Sami. Of these, 966 did not speak the Sami language.

In the census of 1970, the number of Sami in Inari was 2172 and in Utsjoki 1077. For the report concerning minorities in Finland, the Ministry of Social and Health Affairs estimated the number of the Sami in 1975 by the studies of Statistics Finland, the statistics of benefits of Kela and over 18 years old voters of the Sami commission and their families (Karjalainen et al 1979). The result was 2173 Sami in Inari and 1051 in Utsjoki and 485 (11%) outside the Sami Homeland.

At the end of 2011, there were about 9,000 Sami in Finland. 65 per cent of them were living outside the Sami Homeland (Sami Parliament 2011), which brings new challenges for the provision of education, services and communications in the Sami language (Lehtiranta 1992).

The development of the number of the Sami and non-Sami in Inari and in Utsjoki municipalities from 1750 until 2011 is seen in Figure 3.

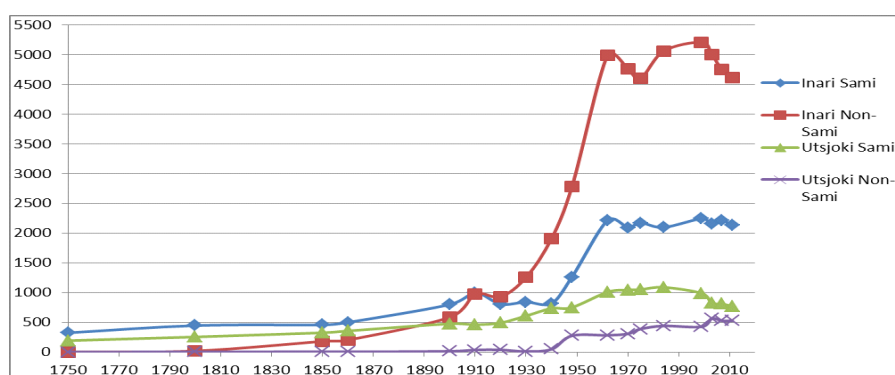


Figure 3. The number of the Sami and non-Sami in Inari and Utsjoki municipalities in 1750–2011. The following references are used: Lapin komitean mietintö 1905, Itkonen 1948, Nickul E 1968, Siuruainen et al 1977, Karjalainen et al 1979, Helander 1991, Sami Parliament 1999, 2003, 2007 and 2011.

2.1.3 THE SUBGROUPS OF SAMI IN FINLAND

Like the total number of Sami, also the number of persons in the subgroups is varying in different sources. The living places in 1962 were about the same as in the map from 1948 in Figure 4.

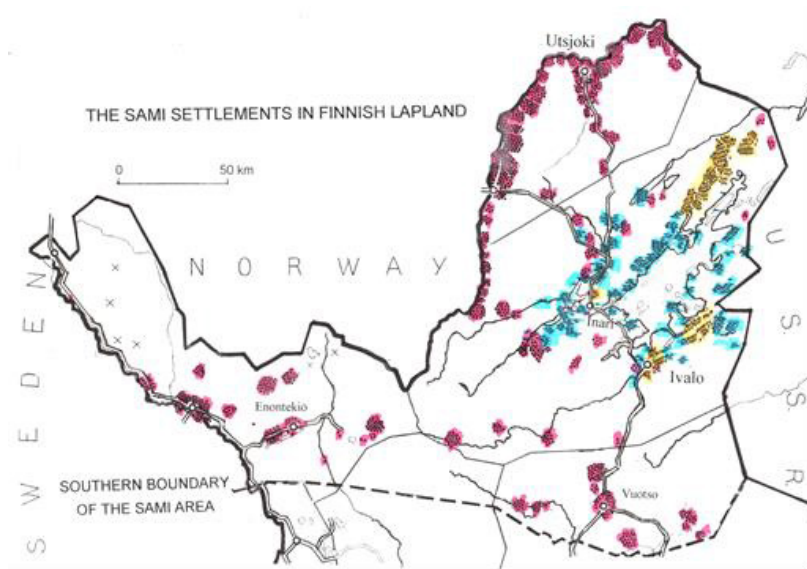


Figure 4. The Sami settlements within the Sami Homeland in Finland in 1948. Reddish points are North Sami settlements, blue areas are Inari Sami settlements around Inari Lake and yellow Skolt Sami settlements

North Sami

The North Sami are also called Reindeer Sami and Mountain Sami and sometimes Fell Sami. They have traditionally been nomads. They shepherded their reindeer using the entire mountain area crossing national borders. A part of them settled down on the river Teno and its side rivers and started small-scale animal husbandry. Those Sami were called River Sami. When the borders of Sweden and Norway to Finland were closed in the middle of 19th century, the reindeer herding Sami came to the mountain areas of Enontekiö, Utsjoki, and a few settled down in Inari as well as a group from Norway in Sodankylä, where the former group of Forest Sami was fused to the general population of Finland and did not exist any longer (Lähteenmäki 2004). The last nomads in Enontekiö settled down in the mid 1960s. The North Sami is the largest and strongest Sami group. There are 30,000 North Sami speakers (Kulonen 2005). The majority of that group nowadays lives in Norway. In Finland, they have been living traditionally in Utsjoki, Enontekiö and Sodankylä, and later also in Inari. The Utsjoki municipality is the only Finnish municipality where the majority of people are still Sami (Sami Parliament 2011).

Inari Sami

The Inari Sami, called also Fisher Sami, are the only Sami group that traditionally lives in a single state, Finland, and in a single municipality. While other Sami groups and Finns have moved into the municipality of Inari for various reasons, the Inari Sami have lived there as long as is known in the same place, around Lake Inari. Their language, costumes, livelihoods, culture and also characters are different from the other Sami (Morottaja 2005). In 1962, there were 559 persons who learned Inari Sami as the first language (Nickul 1968). In 1995, there were 324 Inari Sami who spoke Sami as their mother tongue (Morottaja 2005). The original and most important livelihood of the Inari Sami was fishing, and later also reindeer herding and small-scale farming. In 1949, the number of members in reindeer herding families was 337, and 86 households also had cows (Saamelaisasiain komitean mietintö 1952). The way of life of the Inari Sami varied according to the season between fishing, hunting and small-scale reindeer herding (Morottaja 2005). The hunting of wild reindeer and beaver was strictly regulated by agreements within the community. Families usually migrated to the shores of the fishing lakes for the summer and to the vicinity of pastures and firewood for the winter. This annual migration was still a typical part of the Inari Sami way of life in the latter half of the twentieth century (Nickul 1970).

Skolt Sami

Before 1939 up until the Winter War, the Skolt Sami lived in Suenjel (Suonikylä), and Paatsjoki in the Petsamo municipality. After the war, Finland had to turn over Petsamo to the Soviet Union. The Skolts from Suenjel wilds (500 persons) were resettled after evacuation to Sevetijärvi wilds, the north part of Inari Lake, and those Skolts, who were living Petsamo village on the Arctic Ocean (about 200 persons), were resettled to Nellim and Mustola villages, south of Lake Inari (Figure 5). The Skolts from Paatsjoki were resettled to Keväjärvi near Ivalo. A few Skolt Sami stayed in the Soviet Union. 20–30 of them were still living in Ylä-Tuloma in 2001 (Rantala personal communication 2001). The Skolts had lived in rather isolated conditions in Suenjel. Those Skolts who were living in Petsamo and Paatsjoki, started earlier to work outside the traditional Skolt commune and also married more outside. Estimates of the inbreeding levels have suggested that the Sevetijärvi Skolts are much more strongly inbred than the Nellim Skolt Sami. All Sami were evacuated for 6 years during the wartime.



Figure 5. The movements (arrows) of the Skolt Sami after World War II.

There was a decrease in the Skolt population during the war years 1939–1945 (Figure 6). The mortality rate of the age group 1–15 years at least doubled during the war years, and the age group 20–30 also had a higher mortality rate than other age groups because of the war casualties. The Suenjel children above the age of one year may have had a higher susceptibility to grave infectious diseases than the Nellim children because of their isolation until their evacuation to Kalajoki during the wartime (Lewin 1971).

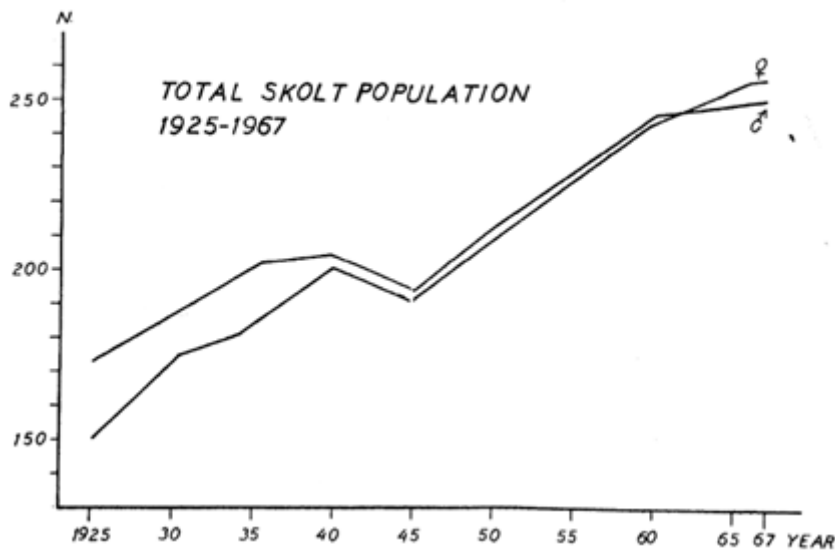


Figure 6. The number of 100 % Skolt Sami from 1925 to 1967. The mortality during the years of evacuation 1939–1945 was high, and that is seen in the figure where the diagram is turning down (Lewin et al 1971).

The Suenjel (Suonikylä) Skolt Sami are considered to be the last form of the so-called Forest Sami culture. According to the communal system, *siida*, the village, was divided into the fishing and hunting grounds for the families in the *siida*. Fishing mainly determined the rhythm of their life (Nickul 1970). The winter time was spent together in the winter village, where houses for the families were situated. In the springtime, the families moved to their summer places, which were usually on some lake, where fishing was possible. In spite of the great inherent friendliness, the Skolt Sami did not readily accept newcomers to the community. They had great family pride and could usually name their ancestors for six generations (Tiilikainen et al 1972). In the 16th century, the Skolt Sami were baptized as Greek Orthodox.

Their livelihoods were fishing, hunting, gathering and raising reindeer. At the end of 1960s, families in Sevetijärvi owned on average 30–40 reindeers. The Nellim Skolts mainly earned their living by forestry and road building work (Lewin et al 1971). After moving to new living places, the Skolt Sami had lost almost everything. The new society was quite different from their former isolated life. The economic situation of the Skolt Sami was not good (Koutonen 1972), and the Finnish state legislated a special act (Kolttalaki 253/1995) to help them. The purpose of the act is to promote livelihoods and subsistence of the Skolts and the area and to maintain and promote the culture of the Skolts. It also defines the borders of the Skolt area as well as defining who is a Skolt.

Hereditary characteristics of the Sami

From the Sami in connection of IBP/HA studies a genealogic sample of 923 persons living in Inari municipality was studied to find as pure Sami as possible for the genetic investigations (von Bonsdorff 1974). Eriksson et al (1975) have studied several hundreds of genes and calculated the genetic distances of different Sami groups and also mixture of them. The Sami subgroups have several genetic differences with each other and with other Nordic populations (Eriksson 1985, 1988). A dendrogram (phenetic tree) is shown in Figure 7. It was computed by using the program “Arbor” after analyzing 88 gene alleles. It demonstrates the genetic distance of different Sami groups and the Nordic populations. Swedish Sami, North Sami in Inari, Inari Sami (Fisher Sami) and Norwegian Sami are clearly separated from the rest of the Nordic populations and the Mari population (Finnish-Ugric population). The Skolt Sami form their own cluster (Figure 7.). Cavalli- Sforza et al (1994) published a similar dendrogram by analysing genetic differences and found that the Sami are on the outermost branch of all European populations.

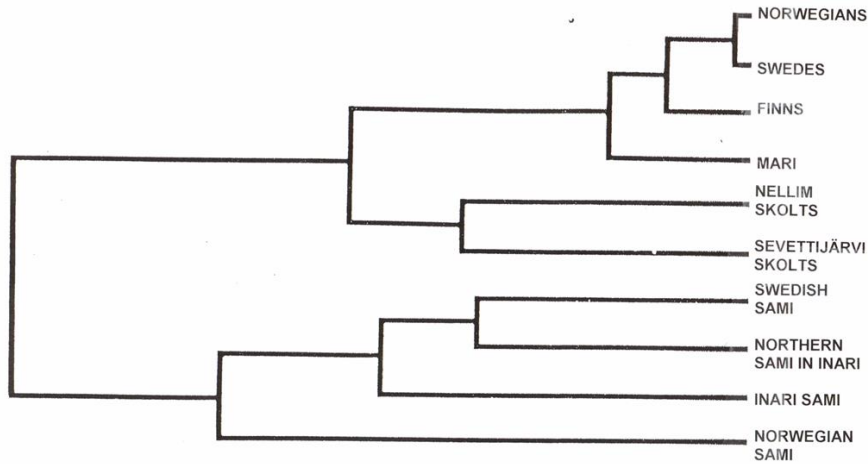


Figure 7. Dendrogram of genetic distances in Sami and other Nordic populations and Mari (Eriksson et al 1985). All groups mentioned in the picture form their own cluster with similar gene alleles. The two dimensional interval describes the genetic distance. For example the Skolt Sami are closer of Maris, Finns, Norwegians and Swedes than the other Sami, which belong to quite different clusters.

2.1.4 THE CHANGING OF THE SAMI POPULATIONS

The natality, mortality and migrations are the determinants of the population size. The crude birth rate (births per 1000 persons) and crude death rate (deaths per 1000 persons) of the Inari municipality are known and seen in Table 1. The corresponding statistics of the Utsjoki population or the Sami separately has not been published. The crude birth rate in Inari municipality has been lower than that of Finland until 1950. Thereafter it has been higher until 2000. The crude death rate in Inari has always been lower than in the whole of Finland. Both have decreased during the years, and in 2000 they were about the same. The crude death rate has been lower since 1871 than the corresponding natality, except during the influenza pandemic in 1920.

Table 1. Crude birth and death rates of the Inari municipality in 1880–2000 (von Bonsdorff et al 1976, Statistics Finland).

Year	<u>Crude birth rate</u> 1/1000		<u>Crude death rate</u> 1/1000		<u>Proportion of Sami</u>
	Inari	Finland	Inari	Finland	%
1840	24.8	34.4	9.9	21.9	100
1850	25.1	35.6	17.3	26.2	100
1860	34.2	36.2	10.0	24.6	71
1870	27.8	36.0	13.9	18.0	¹ 70
1871-1880	31.1	37.0	17.5	22.2	¹ 65
1881-1890	32.2	35.0	18.6	21.3	¹ 60
1891-1900	31.4	32.0	12.7	19.9	58
1901-1910	34.9	32.4	14.7	18.7	51
1911-1920	21.6	27.0	28.2	18.9	46
1921-1930	21.3	23.6	11.5	14.9	40
1931-1940	22.4	19.7	13.0	14.0	35
1941-1950	19.8	24.3	12.8	13.6	(1948) 31
1951-1960	31.3	20.7	7.1	9.3	31
1960-1970	21.0	16.7	6.5	9.5	31
1990	15.2	13.1	7.8	10.1	30
2000	9.1	10.9	9.4	9.5	30
2013	9.4	11.0	10.3	10.0	30

¹ = estimation

Migration has occurred mostly outside of a population, but sometimes also inside, when somebody married a partner from the neighbouring population. For example, the Inari and Skolt Sami have several mixed marriages. The parish registers of 1925, 1945 and 1965 showed that 8% and 15% and 13% respectively of the pure Skolt Sami males had migrated from the Skolt community (Lewin et al 1971). The corresponding figures for females were 9% and 18% and 17%. The same had occurred in the other Sami groups, too (Asp 1966). There is no official Sami register in the Nordic countries of Finland, Sweden and Norway, and therefore it is not possible to follow the migrations of the Sami. The Sami council has its electorate list through which the living places of those voters are known.

In 1962, most of Sami were living in Sami municipalities and only 5% outside the area (Nickul 1968), but in 2011, 65% were living outside and 35% in the Sami home area (Figure 8.).

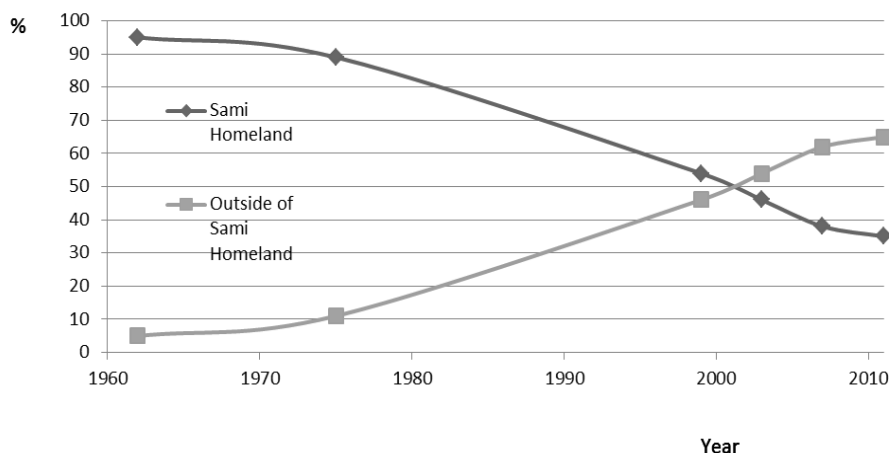
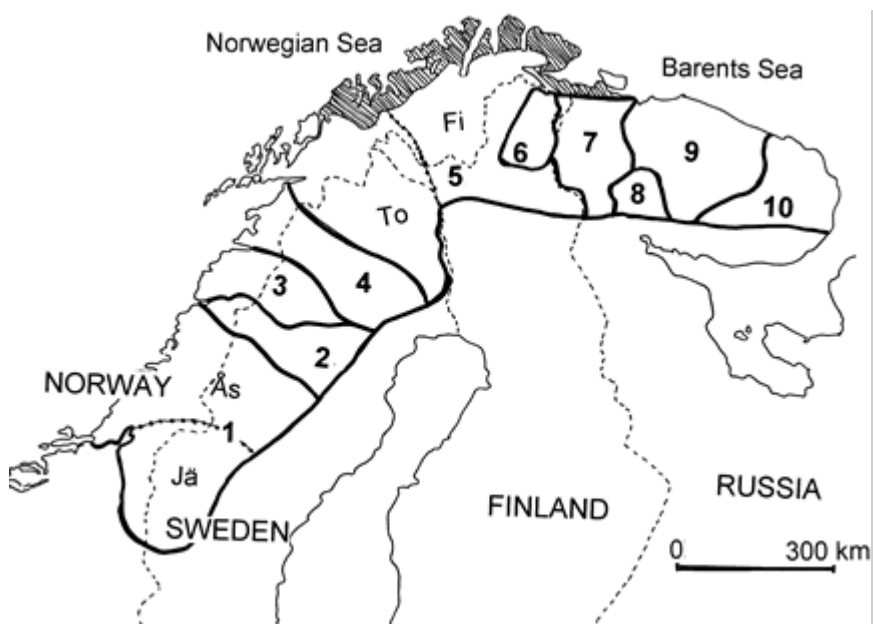


Figure 8. The percentage of the Sami in Finland 1962–2011 living in their Homeland (diamond) and those living outside the Homeland (square) (Year 1962: Nickul 1968, Year 1975: Karjalainen et al 1979,, 1999–2011: Sami Parliament 2011).

2.1.5 SAMI LANGUAGE

The Sami language belongs to the Finno-Ugric languages. The Sami language is not one language, but 4–10 different languages or dialects, depending on the assessment method, because the language is a continuum, which does not have clear borders (Lehtiranta 1992). The most language–and dialect borders are transverse in the same directions as those rivers that drain into the Gulf of Bothnia and into the oceans (Figure 9). Some of the Sami languages have disappeared. In most contexts, the term “Sami language” refers to the largest and most widely spoken Sami Language: North Sami. In 1978, Norway, Sweden and Finland accepted a common orthography for it. The Inari Sami have their own written language, which was introduced at the beginning of the 20th century. From a historical point of view, the Sami languages can be divided into two main groups with the border lying between the North Sami and the Inari Sami. In addition to the Inari Sami, the eastern Sami languages include Skolt Sami, Kildin Sami, Akkala Sami and Ter Sami. The borders of Sami dialects and languages are seen in Figure 9. The Sami languages have traditionally been spoken languages, and the written form came much later. The first written Sami was based on the Swedish Umeå-Sami. It was used already in the 17th and 18th centuries. The Skolt Samis were the last to get an orthography of their language. The ABC-book for the schools came in 1973 (Moshnikoff 2005).



1. Lullisápmi (South Sami)

Jä = Jämtlánda- (Jämtland dialect)

As = Åselesápmi (Åsele dialect)

2. Ubmisápmi (Ume Sami)

3. Bitonsápmi (Pite Sami)

4. Julevsápmi (Lule Sami)

5. Davvisápmi (North Sami)

To = Durdnos dialect (Torneå dialect)

Fi = Finnmárkkku dialect (Finnmark dialect)

/// = mearrasápmi dialects (Maritime Sami dialects)

6. Anárašsápmi (Inari sami)

7. Nuortalašsápmi (Skolt Sami)

8. Áhkkilsápmi (Akkala Sami)

9. Gielddasápmi (Kildin Sami)

10. Darjesápmi (Ter Sami)

Figure 9. The Sami languages and dialects: 1–5 western languages, 7–10 eastern Sami languages, 6 Inari Sami between western and eastern languages (Lehtiranta et al 1992).

2.1.6 SAMI LIVELIHOODS

Originally, the Sami livelihoods were hunting, foraging, and fishing and, later, reindeer herding (Lehtola 2013). The way of life in each Lapp village was determined by the local natural environment, the seasonal rhythm of the area, the ecology of the game, the regional distribution of useful plants, and the productivity of the biomass. In the traditional way of life, people relied on diverse sources of livelihood and moved between several areas according to the seasons. As late as the 1960s, more than half of the inhabitants of the Finnish Sami Homeland earned their living from nature-based occupations. Since then, the situation has changed greatly. The share of nature-based occupations is now only a third. The importance of services has increased. Especially in the municipal and population centres, the occupation structure of the Sami is very similar to that of the dominant population. However, in the sparsely populated areas, nature is still an important source of livelihood. The Sami earlier found employment in occupations that demanded little schooling and work experience. That is not the case anymore. Reindeer herding is a means of livelihood that has been the “genuine” Sami culture. Tourism has increased dramatically in the Sami Homeland since the 1960s. It has become a new source of income for the Sami, as they have been able to offer their expertise to those interested in recreation in the midst of northern nature.

2.1.7 LEGISLATION CONCERNING SAMI

The new constitution (731/1999) of Finland came into force on 1st March 2000. The basic rights of the Sami were legislated first with the change of constitution in 1995. The equivalent regulation in the new constitution is in its second chapter, which concerns the basic rights (17§, 3rd subsection): “The Sami as an indigenous people, the Roma (gipsies) and other groups have the right to preserve and develop their own language and culture. The right to use the Sami language when associating with the authorities is legislated.” The Sami language law (1086/2003) applies to all the Sami languages spoken in Finland Inari-, Skolt- and North Sami. The Inari and Skolt Sami are minorities within a minority language continuum. Authorities have to use those languages when dealing with Sami if needed. All official notifications have to be printed in all three Sami languages in the Inari municipality. Furthermore, interpreters for all three languages are needed in Inari. In other municipalities in the Sami homeland, only North Sami is spoken. The state gives financial support for these extra costs of the Sami municipalities. Since 1996, the Sami have had constitutional self-government in the Sami Homeland in the spheres of language and culture. This self-government is managed by the Sami Parliament, which is elected by the Sami. The Sami Parliament, Sámediggi, is responsible for the planning and enforcement

of the Sami self-government, which is provided by the Finnish Constitution, in the spheres of language and culture. The Norwegian Sami Parliament was established in 1989 and the Swedish one in 1993 (Seurujärvi-Kari 2005). The Skolt Sami also maintain their tradition of village administration under the Skolt Act (253/1995) within the area reserved for the Skolt Sami in the Sami Homeland. There is wide legislation, which helps and has helped the Sami economically for example to build homes and found so-called reindeer farms.

2.1.8 SAMI HOME AREA MUNICIPALITIES INARI AND UTSJOKI

Inari is the largest municipality in Finland, and it has the biggest Sami population. Its land area is 17,334 km² and water area 2,281 km². The population at the end of 2011 was 6754 including 2137 Sami (32%) (Sami Parliament 2011). Inari is the only 4-language municipality in Finland. Utsjoki is the most northern municipality in Finland, 5370 km² wide. It is the only municipality where the majority are Sami; from 1294 people 768 are Sami (59%) (Sami Parliament 2011). The distance from Utsjoki village to Helsinki is 1267 km, to Rovaniemi 453 km and to Ivalo 164 km (Utsjoki. General information 2014). People in the northern municipalities of Lapland can get benefits for their livelihoods according to the Act on financing and support for reindeer herding and primary production (986/2011).

2.2 THE ENVIRONMENT OF THE SAMI

2.2.1 THE CLIMATE AND WEATHER

The location of the Finnish Sami area is arctic, between latitudes 68–70°, but the climate is subarctic. The southern border of the “Samiland” (Vuotso) is about 200 km north from the Arctic Circle. Because of the warm Gulf Stream and Atlantic Ocean, the temperature in the area is higher than in other places on the same latitude. The temperature of Utsjoki is 10 degrees higher than it was without the Gulf Stream. The mean temperature in February in Kevo, Utsjoki during the years 1961–1970 was -15.7°C and in Inari -14.0°C (Huovila 1974). The corresponding mean temperatures in July were +12.7°C and +13.7°C. The length of the winter is more than 200 days. The long winter is demanding for safe systems for everyday medical work. Special readiness and skills for rescue in the cold and dark environment are needed and also emergency engines, aggregate for a break in electricity. Freezing temperatures restrict working with several medical equipments (Soininen 1988).

Climate and weather are important factors in the emergence of diseases in humans (Parkinson et al 2005). Cold loads the body with several physiological

changes (Mudge et al 1976). Environmental temperature is closely associated with mortality (Näyhä 2005). Seasonal variation of ischaemic heart disease (IHD), with higher mortality in winter is known, exposure to cold probably being the underlying reason. It can be regarded as one of the risk factors for IHD (Näyhä et al 1995). An increased risk of adverse health effects of a cold climate is present in subjects having chronic obstructive pulmonary disease, respiratory asthma, conjunctivitis or allergic rhinitis, earlier frostbite, diabetes, hypertension, coronary heart disease, chronic neurological diseases, Raynaud's phenomenon, cold urticaria, history of hand vibration or current smoking (Hassi et al 2005, Harju et al 2010, Näyhä et al 2011).

A prerequisite for coping in a cold climate is possibly to adapt to it and to protect oneself for cold in working and housing. Andersen et al (1960) have studied the acclimatization of Norwegian nomadic Sami and found it different from the cold adaptation of Inuits, whose adaptation was increased metabolic heat production. The core temperature among Sami was decreased, like an insulating type of adaptation. The Sami exhibited a smaller increase in oxygen uptake, indicative of less shivering, compared to control subjects. The Sami also maintained warmer skin during cold exposure than persons not acclimatized. Crile et al (1939) studied the basal metabolic rate of Chippewa Indians and Inuits in 1937 and found that it was higher in both groups and was regarded as adaptation to the cold.

Krog et al (1969) studied the circulatory effects, cold induced vasodilatation by ice-water immersion of the hand of Skolt Sami and Norwegian Sami and found that they reacted differently when compared to the non-Sami control group. Fishing in cold waters demands good adaptation of the hands. Krog et al got the general impression that from the circulation point of view, the Skolts respond to the cold stress in the same way as the Norwegian Sami, demonstrating a marked cold-induced vasodilatation which started earlier than in the control group.

In spite of cold adaptation, frost bites occur. From the reindeer herders in Finland, 22% told that they had got frost bite during the previous year 1987. The most common site is the face because of the "wind chill" effect when driving the snowmobile (Ervasti et al 1993). The annual occurrence of mild frostbites among the general population in Finland was 13% and severe frostbites 1% (Mäkinen et al 2009).

Appropriate clothing is crucial in a cold climate. Arctic people have precise traditions how the clothes are made. The design and sewing of the clothes has developed during centuries. Earlier the Sami clothes consisted only of reindeer skin. Those Sami who had sheep began to spin different kinds of wool thread and knit fabrics and baize and used them for clothes. "Peski is a fur coat which is put on over other clothes, and it is very warm, but makes working clumsy. Peski has the fur on the outside. In the underwear, the fur side was on the inside against the skin (Itkonen 1948). Today the Sami reindeer herders wear overalls, which are

designed for snowmobile driving, but they still use the traditional fur boots, which are the best. Until the 1960s they were filled with hay, but nowadays with wool socks. In a snow storm, the “lukka” is practical garment. It is a cap with big hem, which rounds the shoulders on other clothes.

There are ways to protect oneself from cold, but protecting the respiratory system does not always succeed (Hassi et al 2005). Schaefer et al found in the 1970s in the Canadian Arctic that many middle-aged and elderly Inuit develop a progressive decrease in the maximum expiratory flow (Schaefer et al 1980). The end result of this so-called Eskimo lung was death from right-sided heart failure. The only proven factor in the patients’ histories was that all had been hunters when young, and the work had involved repeated episodes of hard physical work, even during the severe cold of winter. An Eskimo lung like phenomenon was also studied later by Regnard 1992, Giesbrecht 1995. Beaudry (1968) had stated that coughing and the production of sputum among Inuits was high. He analysed FEV (forced expiratory volume) and MMF (maximum mid-expiratory flow rate) among 1,057 Inuits in 1966 and found large numbers of individuals having values below the lower limits of normal. The possible causes were thought to be repeated respiratory infections, smoking, indoor air pollution (seal oil lamps) and working conditions (strenuous exercise).

The risk of chronic bronchitis symptoms was elevated among outdoor workers (N=876), but not among regular recreational cross-country skiers (N=1497) when persons in Finnish Lapland were studied by Kotaniemi et al (2003). Neither was the risk of asthma significantly elevated by regular exercising, or by working in a cold climate. For those who have difficulties breathing cold air because of disease or strenuous work, a mask that saves the warmth and humidity of breathed air has been introduced (Soininen et al 1981).

The cold climate also has indirect effects. The winter air on the continent is dry, and because of heating, the inner air is still dryer. Dryness inhibits the healing process of all mucous membrane diseases, for example the common cold, complicates easy ear- and sinus diseases and respiratory infections, bronchitis or even pneumonias (Beaudry 1968). Otitis media often complicates to chronic infection, perforation of the ear drum and hearing disturbances among children living in the cold climate (Baxter et al 1986). The inner air can be very unhealthy in the wintertime because of particulate matter and gaseous contaminants from heating, especially if someone is smoking indoors (Åkerblom 1975, Guggisberg et al 2003).

2.2.2 LIGHT AND ULTRAVIOLET RADIATION

Light is the most important environmental factor, because the intensity of biological life in an area depends on its energy. Light is the timer, “Zeitgeber” of life. All living creatures have their inner clock that measures their daily (circadian) and their

seasonal (circannual) time. The circadian rhythm in animals functions in 24.18 hours (24 hours and 11 minutes) periods (Czeisler et al 1999). Animals, including humans, north of the Arctic Circle must adapt to the seasonal change of light. Today artificial light and social life are operating as “Zeitgebers” (Shanahan et al 1997).

Utsjoki is in the same position in terms of sunlight as areas on the same 70° latitude in the northern parts of Alaska and Siberia and the middle part of Greenland. The strong changes of the darkness and lightness have an influence on the mind and behaviour of humans (Hakko et al 1998, Saarijärvi et al 1999). The sun is invisible for 51 days in Utsjoki. That is the polar night. The polar day is the summer when the sun does not go down under the horizon for 73 days and nights. Some people in the north have sleeping disturbances when the dark period begins and some have in the spring and summer when there is light all the time (Øygard 1974).

In the dark time of the year, a lack of light is connected with seasonal affective disorder (SAD), winter depression (Rosenthal et al 1984). It has been characterized by the fall onset of depressive symptoms of an “atypical pattern” featuring hypersomnia, irritability, weight gain and carbohydrate craving (Booker et al 1992). The spring remission of depression may be followed by euthymia or hyperthymia with decreased need of sleep, weight loss and increased energy. Sleep patterns and problems are major components of the SAD syndrome. SAD increases with increasing northern latitudes. Women are more affected than men, young people more than old. Saarijärvi et al (1999) have studied SAD among the rural Finns and the Sami. There was no difference between people in the north and south in Finland, but they found that the prevalence of SAD was significantly more common among the non-Sami than among the Sami in the 3 most northern municipalities of Finland. The prevalence of SAD varied in Greenland between the four municipalities studied (Kegel et al 2009). The prevalence was particularly high in the northern municipalities, and no significant difference was found in the prevalence between Greenlanders and Danes. Booker et al (1992) compared SAD of Natives and non-Natives in Alaska and in Siberia. They found that SAD was absent among Siberian Natives, but the prevalence of SAD among Alaskan Natives was comparable to the rest of the population. In all these studies in Finland, Alaska and Greenland, the prevalence of SAD was about 9% (Saarijärvi et al 1999, Kegel et al 2009, Booker et al 1992).

It is also found that luminosity in spring disturbs the sleep-wake rhythm. Mental disorders among some people worsen in the spring (Näyhä et al 1995). Another biological effect that human subjects encounter in spring is an increase in self-destructive behaviour. Suicides in northern countries have an increased occurrence in spring (Näyhä 1985, Hakko et al 1998).

Melatonin is connected with many physiological procedures in physiology. It is a derivative of serotonin, which is produced from many body tissues, including the

pineal gland, retina and the gastrointestinal tract (Bubenik 2008). In other animals, the pineal gland is also called “the third eye”, because by them it can respond directly to the light. Light influences the fertility of the animals via melatonin and sexual hormones (Timonen et al 1964). Sunlight or bright artificial light inhibits the secretion of melatonin in a few minutes. Melatonin can have a co- or anti gonadotrophic effect depending on the species. In the north, most people are born in early spring, 9 months from the time when the sun is maximally shining in June-July. That is the gonadotrophic effect of melatonin in humans. For many animals and also earlier for humans, it is important that the youngsters are born in early spring, otherwise their survival is uncertain. (Leppäluoto 2005)

Ultraviolet radiation in the springtime in Lapland is stronger than in southern parts of Finland (Rossi 1974, Manney 2011). The ozone layer above the North Pole has diminished like above the South Pole and because of that the UV-radiation has also increased in the northern areas (IASC 1995). Already earlier it was known that in February, a 4 hour exposure to the sun can lead to tanning (Rossi 1974). Snow can reflect 80% of the sunlight (the albedo), and therefore without sunglasses the UVB radiation can cause snow blindness, painful photokeratitis. During 1960–1978 the incidence of snow blindness, if calculated from the health centre visits of Sami, was 1.5/10,000/year (Soininen unpublished). The result is consistent with the fact that acute snow blindness is not a major problem among the Sami and neither among Inuits. Arctic populations have learned to protect their eyes by using various kinds of shades. It is now known that only some sunglasses give sufficient protection against UV-B radiation (IASC 1995). UV-light results in climatic keratopathy, pterygium and pinguecula (Forsius 1976, Taylor 1989). UV-B radiation can also cause skin cancer and eye cataracts, age-related macular degeneration (Chalam et al 2011) and damage the retinas of children (Roberts 2011), and it has destructive effects on the immune system (De Fabo 2005). The Sami do not have eye cataracts or angle-closure glaucoma. Inuits and Mongoles have angle-closure glaucoma. The Sami have some open-angle glaucoma and exfoliation syndrome. (Forsius Henrik 2014, personal communication).

The production of vitamin D by sunlight is not, however, sufficient because of the clothing in the North and it is necessary to have vitamin D in food. Rachitis was a problem in small children of the Swedish Sami still in the 1960s (Melbin 1962). The signs of rachitis could be seen also in the 1960s in Finnish Sami children (Louekari 1967).

In connection with the study of climate change, the impact of UV radiation on the northern nature and humans are studied at the present time (De Fabo 2005). There has always been UV-radiation in the northern latitudes, but the increase now belongs to the “manmade environment or disturbances”, to which also belongs physicochemical pollution.

2.2.3 CHEMICAL POLLUTION IN THE AREA OF THE SAMI

Environmental pollution arises from local emissions or they can be transported via air, rivers, or sea. The Arctic areas have been generally considered as clean, non-polluted areas, until it was found that the pollutants originating from industrial areas and densely populated areas were transported to the Arctic areas (AMAP 1998). When the facts about nuclear explosions and the emissions from Arctic industry near the Russian border came to light in Finnish Lapland, they caused a lot of concern (Miettinen 1965, Koivusalo et al 1996, Rasmus 2010).

“Arctic haze” is an arctic phenomenon that was noticed by the Inuit soon after the industrial revolution began, and in the mid-1950s pilots flying over the Canadian High Arctic began to report periods of reduced visibility due to a brown-tinged haze (AMAP 2006). This became known as “arctic haze” (AH), and it was seasonal, peaking in early spring. It was most severe during periods of clear, calm weather. It became obvious in the 1970s when chemical fingerprinting showed that its source was clearly related to human activities. Since then, studies have shown that the haze is mostly due to emissions from industrial activities in several countries around the world. AH is a complex mixture of microscopically small particles and acidifying pollutants. Arctic haze has caused people to notice the fact that pollutants do not obey national boundaries.

The Arctic, because of its ecological fragility, is especially susceptible to the effects of industrial pollutants in its environment. In arctic food chains, mercury and several fat-soluble pollutants are cumulating to fish and marine mammals. When the concern about the arctic environment became increased, all 8 arctic countries decided to establish a common monitoring project in 1991 called the Arctic Monitoring and Assessment Project (AMAP), which was established as a result of the so-called Rovaniemi process. Human health was also assessed, and that subproject was called AMAP, Human Health. Developing offspring either in the foetal state, as neonates, or in the growing age are the most sensitive to environmental pollutants. During the mother’s pregnancy, toxins may transfer to the foetus, or through breastfeeding to the neonate. That is the reason why the targeted group in the AMAP human health project was expecting mothers and their neonates. A newborn infant is the final destination of the food chains for fat-soluble environmental toxins, when these toxins transfer into the breast milk from the mother’s fat tissue (AMAP 1998).

At the end of the 1980s, the pollution, which had happened already for years on the Russian side of the eastern border of Lapland, came to light. People had visited Nickel and Monchegorsk in Murmansk County and seen all the destruction and the dead grounds around the metal foundries (Koivusalo et al 1996). It became evident that the smelters had been working since the 1940s, and from the 1970s the

use of Norilsk ore began, which has 30% sulphur and several metals. It was clear that some pollution could also drift to the Finnish side. That and the forest damage in Eastern Lapland attracted attention and raised concerns among the people in Lapland (Rasmus 2010). Several research projects started because of the common worry (Tikkanen et al 1992).

The Severonikel complex in Monchegorsk is the largest smelter on the Kola Peninsula, and processes enriched copper and nickel ore and nickel matte from the Norilsky Combine and the Pechenganikel Plant. The plant also uses scrap metal and waste and raw materials from domestic and international suppliers. Wastewater and atmospheric emissions from the plant are formed during the hydro- and pyrometallurgical processing of the raw materials and in the production of sulphuric acid from the production waste (Figure 10). In addition, heavy oil (230 000 tons in 2002) is burnt in a power plant to provide heat and part of the electricity supply to the plant. The first AMAP assessment identified the non-ferrous metal smelters on the Kola Peninsula and at Norilsk in northern Siberia as the largest (anthropogenic) sources of acidifying air pollutants within the Arctic (AMAP 1998).

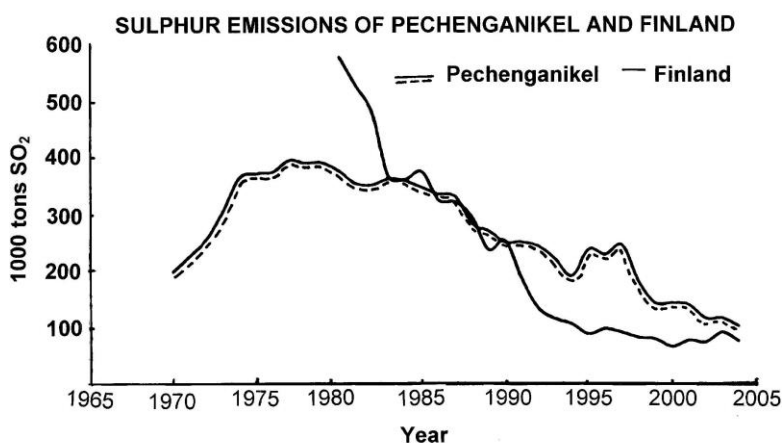


Figure 10. Sulphur emissions (1000 tonnes of SO₂) from the Pechenganikel smelter complex and total Sulphur emissions of whole Finland, starting from 584,000 tons per annum from 1970 (Data: Kola GMK Company / Paatero et al 2008).

Sulphur emissions (Figure 10) from the whole Murmansk area were about 900,000 tons per year in the 1970s. It was distributed to the northern parts of Norway and Finland (Figure 11). Copper and nickel emissions peaked at over 6000 tons per year in the 1970s and late 1980s, but fell during the first half of the 1990s to below 1 000 tons per year (Paatero 2008).

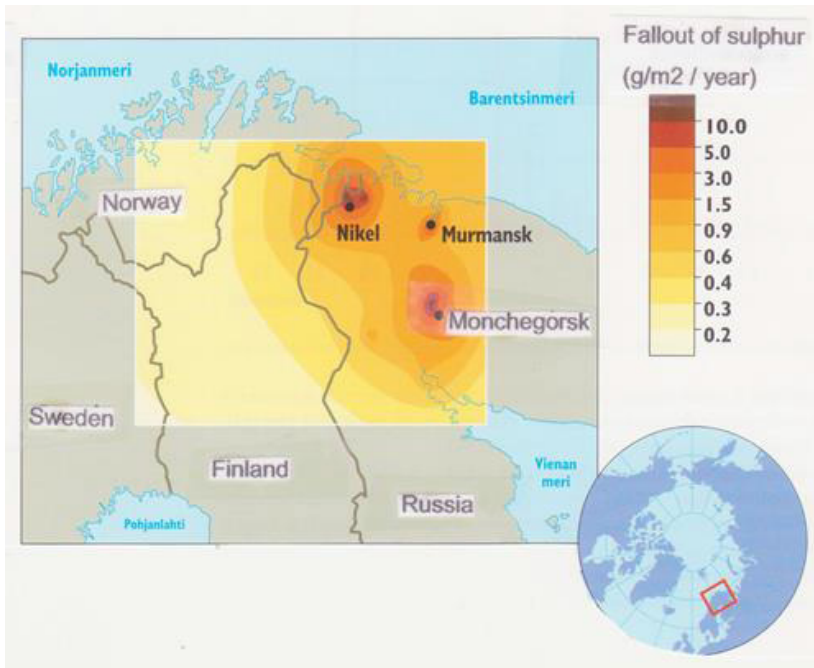


Figure 11. The spatial distribution of the modelled Sulphur (S) deposition per year, $\text{g S} / \text{m}^2 / \text{year}$ from July 1990 to June 1991. (Tuovinen et al 1992, Mähönen et al 1997)..

In addition to sulphur, nickel and copper, in the fallouts there are arsenic, chrome, cadmium, manganese, lead, vanadium and zinc (Paatero et al 2008). Sulphur dioxide changes to sulphuric acid with water and acidifies the lakes and soil. Acid soil in turn promotes metals to drain into rivers and lakes along with rain, and the acidification of the soil enhances so the uptake of metals by plants and further to animals.

The acidification of small lakes in Finland was reduced after the start of the new millennium due to the lower atmospheric load, both from the Kola Peninsula and from the densely industrialized and populated parts of Europe. (Paatero et al 2008).

The impression of the seriousness of the situation in the beginning of 1990s was worse because of the high amounts of emissions from Monchegorsk and Pechenganikel smelters. It has been found that the risk of chronic cough and phlegm was significantly increased among the people who were living in Monchegorsk when compared with people living outside. After adjustment, the smoking odds ratio, OR was 2.16 (95% CI 1.07–4.35) (Nieminen et al 2013).

The Nickel (Ni) and Copper (Cu) concentrations in all types of berries closest to the smelter were above the maximum allowable concentration in foodstuffs for human consumption of 0.5 and 1.0 mg/kg dry weight (dw) (Derome et al 2007). In eastern Lapland, the concentrations of copper in crowberries were mostly 0.1–5.0 mg/kg dw and Nickel concentrations 0.8–1.1 (Paatero et al 2008). Near

the border in some plots the concentration was >1.1 mg/kg dw. In cowberries, most copper concentrations were 0.5–1.0, and nickel concentrations 0.5–3.0. The concentrations however showed a clear decreasing trend with increasing distance from the smelter complex. At 270 km from the smelters, all concentrations of the berries were practically zero (Derome et al 2007).

In Lapland the food chain of mercury (Hg) in waters, fish and man has been studied (Sumari et al 1972, Lodenius et al 1982 and 1983). Mercury is an example of a metal which is easily washed into lakes, when acidification increases and when the height of the water is regulated. The same has happened in artificial lakes when they were formed. The mercury changes into organic methyl mercury and accumulates into fish and in that way to humans. There were high mercury concentrations (Appendix 2) in those people who ate a lot of fish from northern pools like Lokka and Porttipahta in southern Samiland or from lakes where water is regulated, like the Lake Inari (Kirjarinta et al 1982, Lodenius et al 1982, 1983, Luoma et al 1992).

Mercury is a nerve toxicant, and it penetrates the blood-brain barrier. It also passes the placental barrier and enriches the foetus, which can be seen in the values of maternal blood and cord blood in Appendix 2. The concentrations of mercury are higher in cord blood than in maternal blood. The guideline for gravid women is 8 µg/L (40 nmol/L). The mean blood concentration of the mothers' blood in northern Lapland was 1.6 µg/L (range 0.2–6.0) and corresponding value of cord blood 2.3 (range 0.4–8.2, significantly higher). (Soininen et al 2002)

Luoma et al (1992) found higher mercury concentrations in the blood of reindeer herders living in the northeast area than in other areas of Lapland. When the mercury concentration of hair of people living in Inari was measured, the values were not higher than near the northeastern border (Mussalo-Rauhamaa et al 1996). When the samples of the same people were analysed 1991, ten years later, the concentrations of mercury were lower in all but one when compared with the samples taken in 1982. (Appendix 2). The concentrations of mercury in the hair and blood of the people in Lapland and other arctic areas were measured in the 1980s and 1990s. Since then, the concentrations in fish and people have decreased. Long-range transport outside the Arctic is going on, and hence the monitoring of fish is needed (AMAP 2011).

Selenium, a trace element, is a substantial part of antioxidative enzymes, and it has been shown to have a protective effect on mercury toxicity (Kosta et al 1975, Seppänen et al 2004, Bjerregaard et al 2011). The Sami get selenium in fish and reindeer meat. The protective mechanism is not known, but a lot of research of marine and freshwater fishes is going on (Mailman et al 2014). Copper and zinc are also regarded as trace elements in small amounts and toxic metals in large amount (Appendix 4).

The elements in fallout near the Russian border also included cadmium,

arsenic and nickel. They tend to accumulate in terrestrial biota over the years to vegetation, animals and humans. They also have been monitored. In old animals the concentrations are usually higher, e.g. cadmium in reindeer and elk liver and kidneys. It is recommended in Finland that the liver and kidneys of reindeer and elk older than 1 year should not be used for food (Finnish Food Safety Authority, EVIRA 2013). Näyhä et al (1991) have reported elevated cadmium concentrations in the blood of Finnish reindeer herders (Appendix 3). The highest values were measured in the Sami living in the northeast part of Lapland near the source of Russian pollution. The blood concentration of 4.8% of men exceeded the upper limit of recommendation of WHO (45 nmol/L). The association of blood pressure and the concentration of cadmium in the blood of 227 male reindeer herders in Lapland were found (Luoma et al 1994). The results suggested that a low-level environmental exposure to cadmium may increase blood pressure, especially in patients suffering from arterial hypertension.

In the Finnish AMAP study, the maternal concentrations of zinc were higher in the mothers living in eastern Lapland than for mothers living in western Lapland.

Approximately 10% of the Lappish mothers had an extremely high urine arsenic concentration of over 41 µg/L (0.5 µmol/L). The mother's age, smoking habits, location of habitation, or ethnic background could not be proven to have a connection to the arsenic concentrations. The maternal urine arsenic concentrations correlated with the newborn urine arsenic concentrations when adjusted with the creatinine concentrations (Soininen et al 2002).

The organochlorine compounds of reindeers was studied by Berg et al (1994) and found that the DDT concentrations in reindeer kidney fat were a little higher than in the bovine fat. The concentrations of polychlorinated biphenyls (PCBs) were also a little higher than in bovine fat. Hexachlorobenzene (HCB) concentrations in the kidneys of reindeer in the northern Lapland were ten times higher than in the Southern Lapland or bovine kidneys in 1991. There was no measurable amount of the pesticides lindane, heptachlorine or chlordane in the kidney fat of reindeers. When the organochlorine compounds of blood of the mothers and their newborn offspring were measured, no elevated concentrations were found in Lapland (van Oostdam et al 2004).

From the beginning of the 1990s, several studies about the concentrations of carcinogenic substances in the Sami and other northern residents have been published. Most studies were concerning mercury, because high values had been found, but also other metals such as cadmium, copper, zinc, nickel, arsenic, lead, chrome and selenium were also studied (Luoma et al 1992, 1994, Lodenius 1982, 1983, Soininen et al 1994, 2000, 2002, 2003, Mussalo-Rauhamaa 1996). In Appendices 3 and 4, the concentrations of metals and trace elements of people in Lapland and for comparison in southern Finland and in other Arctic areas are given.

The environmental researchers (Paatero 2008) say that the trans-boundary pollution originating from the Kola region has levelled out, but it was significant enough to cause elevated pollution concentrations for the Lappish people. Cadmium and mercury concentrations were higher in the blood of northeastern reindeer herders and there was an elevating tendency towards northeast Lapland (Näyhä et al 1991, Luoma et al 1992). Cadmium concentrations of reindeer herders' blood also showed to have a connection with high blood pressure. The blood and urine arsenic concentrations of some mothers and newborn were also raised and would need some more investigations. The mercury problem was known already earlier and orders were given to the population (EVIRA 2013).

2.2.4 RADIOACTIVITY

Radioactive radiation is mutagenic and carcinogenic, especially when the source of radiation is inside one's body, as was the case of reindeer meat-eating people in Lapland. Radioactivity is known to cause several cancers: leukaemia, breast cancer, thyroid cancer, stomach cancer, cancers of the urinary bladder, colon, lung, ovary, bone, non-melanoma cancer of the skin, brain and nervous system. (UNSCEAR 1994)

The two major sources of radioactive fallouts in the Arctic region have been nuclear weapons testing and the Chernobyl accident (AMAP Assessment report 1998). The dumping of radioactive waste on the northern shore of Kola peninsula is a threat too, but it has been followed up by taking samples, and the radioactivity has diluted at least that part that is discharged into the sea. A working atomic power plant is in Kantalahti and atomic explosions in mines (AMAP radioactivity report 2009).

Since the first nuclear weapons test in 1945, more than 800 nuclear explosions have taken place (HASL 1964, Mussalo-Rauhamaa 1981). In the first phase 20–30% of the 250 explosions entered the stratosphere. In the second phase, nearly all of the 175 explosions entered the stratosphere. In the third phase, about 60 explosions have been carried out in the atmosphere, while more than 300 underground explosions have been reported. When the particles reach the stratosphere, they can float there for very long time. They spread themselves apart horizontally, so eventually particles are found throughout the whole of the stratosphere. In polar regions during winter and early spring, vertical mixing brings material down into the troposphere, which in turn is then cleansed by precipitation. Most of the fallout came to the northern half of the globe, maximum to the 40–45 latitudes. The fallout included several radionuclides and some of them have enriched in the food chains in the Arctic.

Of the nuclear test explosions, 88 have taken place in the Arctic on the island

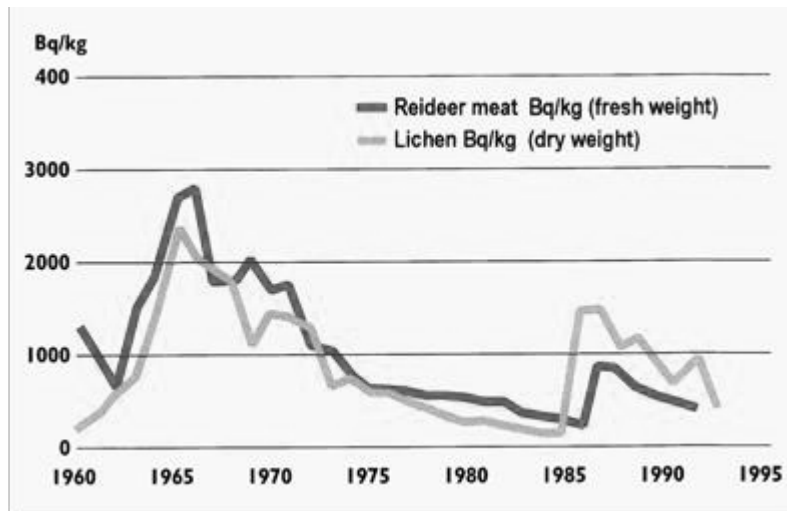
of Novaya Zemlya (AMAP radioactivity report). The majority of radio caesium deposition occurred during the period 1955–1966 as a result of global fallout from atmospheric nuclear weapons tests performed in the northern hemisphere. The predicted ground deposition in Finnish Lapland was 1400 Bq/m². The highest was in Iceland 2900 Bq/m² and lowest in East Russia 700 Bq/m².

The investigations of the arctic food chains started in Finland in 1959 (Miettinen et al. 1961). Three noticeable food chains were identified. Surface water – sedges and horsetails – beef and milk, surface water – plankton – fish – man and lichen – reindeer – man. Several radionuclides were estimated in Finnish Lapland (Mussalo-Rauhamaa 1981, Rahola 1992). Cs-137 and Sr-90 are long-lived and of considerable significance as contaminants of food and the human body. Strontium behaves like calcium and accumulates to the bones of reindeers. Lead and polonium are also stored in bones. Cs-137 behaves like potassium and accumulates to muscles of the reindeer and in that way to the humans. That is why the lichen-reindeer-man food chain has proved to be the most important one for reindeer herding populations.

Ecological factors, not a high fallout level, accentuate the enrichment of Cs-137 through these food chains. Low potassium content, hard climate, few species, great dependence on a few food species made the enrichment of caesium happen (Rahola 1977).

By whole body counting of the gamma radiation of people, it was found that the mean body burden Cs-137 in Finnish male reindeer herders reached its maximum value of 55,000 Bq in 1965 (Rahola 1992). After that it started to decrease. In April 1986, it was 5,000 Bq for this group and 3200 Bq for all Sami (Figure 12). When calculated to Gray-units (Gy), which is the absorbed amount of radioactivity, the highest values were over 2000 µGy in reindeer herder men (Kurtio et al 2010). From that whole body counting of people yearly since 1961, the radiation doses are calculated for northern people.

A



B

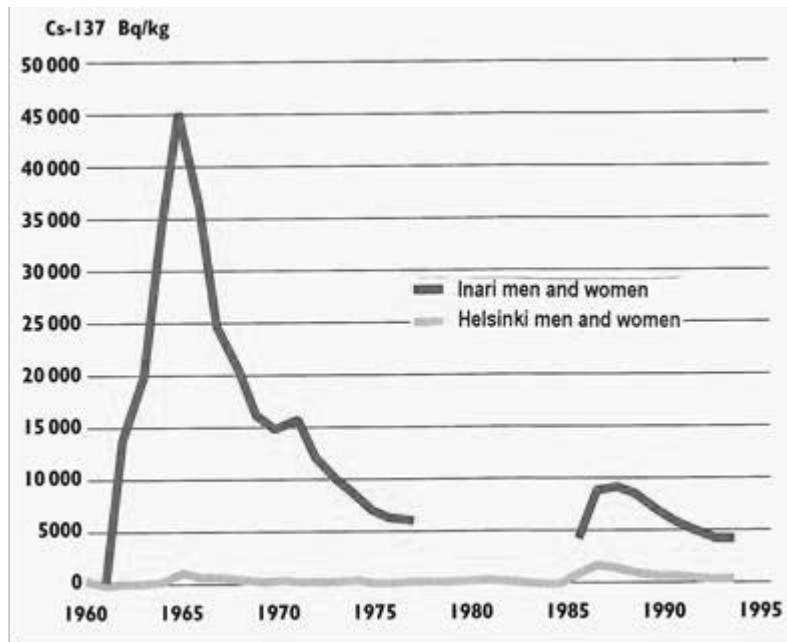


Figure 12. Figure A: The radioactivity caused by Cs-137 (Bq/kg) of lichen and reindeer meat. The samples of lichen are from Kaamanen, Inari and the radioactivity of reindeer meat is from reindeers slaughtered in Inari and Utsjoki. Figure B The radioactivity in men and women living in Inari (red) and Helsinki (yellow). Cumulation of radioactivity from lichen and reindeer meat to people is seen in these figures (Rissanen 1997, Mähönen et al 1997).

Cesium-137 was the most important radionuclide, which cumulated into the Sami, but there were also other radionuclides, which cumulated to the organs of the Sami. Cesium-137 (Cs-137), strontium-90 (Sr-90), lead (Pb-210), polonium (Po-210), plutonium (Pu-239), (Pu-240) and (Pu-238) activities has been estimated of lung, liver, muscle and bone samples of male Sami (Mussalo-Rauhamaa et al 1981). The concentrations are seen in Table 2. Cs-137-concentration in the liver of Sami people was about 40 times higher than that in liver of the southern Finns. The ratio of Pb-210 concentration in liver of the Sami to that of the southern Finns was 1.8. For Po-210 the corresponding ratio was 5.6. The ratio of Pb-210 and Po-210 concentrations in placentas of the Sami to those of southern Finns were 2.3 and 12.4, respectively, in 1967 (Kauranen et al 1969).

Table 2. The concentrations (pCi) of radioactive cesium(Cs-137), plutonium (Pu-239, Pu-240), lead (Pb-210), polonium (Po-210) and strontium (Sr-90) of liver, lung and bone tissues in 1970s (Mussalo-Rauhamaa 1981).

Tissue	Cs-137	Pu-239, Pu-240	Pb-210	Po-210	Sr-90
Liver of the Sami	2160	0.42	13,0	86,2	-
Liver of the Southern Finns	<50	0,41	4,3	15,4	-
Lung of the Sami	1180	0,03	2,4	8,2	-
Lung of the Southern Finns	<50	0,033	3,3	3,9	-
Bone of the Sami	-	0,045	-	-	1,9
Bone of the Southern Finns	-	0,049	33	29	0,81

The Cs-137 concentrations in lung indicate the same dramatic difference between Sami and southern Finns as found for liver. The Pb-210 content of the lung was about the same in both population groups, and the Po-210 content of the Sami was about twice that of the southern Finns. The Pb-210 and Po-210 concentrations in bones of the Sami did not differ from those of the southern Finns. The average Sr-90 concentration in bone of the Sami was about twice that of the southern Finns. The fallout of Sr-90 concentrated mainly in bone of reindeer, and thus there is a break in the transfer of Sr-90 along the food chain lichen – reindeer – man.

2.3 THE WAY OF SAMI LIFE AND HEALTH RISKS

2.3.1 NUTRITION

Fish and reindeer have been the overpowering food of the Sami, and they still are. Game is still important food, especially elk. All but the skin and bones of the reindeer were eaten (Itkonen 1948). The bone marrow is a great delicacy, even today. The bare bones were brought back to the nature. If there were some parts of the viscera left, they were given to the dogs. There were several ways to make food from the parts of the reindeer. The best part of leg and tongue were sold. Reindeer milk was earlier used and several sorts of cheese and sour- and dried milk produced. According to Ruong (1982), the milking of reindeer ended in the 1920s in Sweden, in Finland later (Itkonen 1948).

Jokelainen (1965) studied the food consumption of the Sami in 1960–1961. 135 families (812 persons) were studied by means of an interview and weighing methods and in 1962 by interviewing 114 men and 60 women to assess the individual diets. The participants in the study were the Sami who were still nomadic reindeer herders in Enontekiö, the reindeer herding North Sami living in a permanent location of habitation along Teno River, Fisher or Inari Sami, and Skolt Sami. The purpose of the study was to investigate the composition of the Sami diet, the main sources of Cs-137 and potassium and their total content in the diet.

There was much seasonal variation in the amounts of reindeer meat eaten by reindeer herding Sami men in Utsjoki. In wintertime from October to April, the Sami men ate even 700 g of reindeer meat per person per day. There was also seasonal variation of reindeer meat eaten among women, but the amounts were much smaller (Figure 13). The reindeer herders from Mountain Lapland used reindeer meat 2–10 times more than in other areas in the reindeer herding area (Province of Oulu and north east part of Lapland) (Hälinen et al 1993).

g/day/person

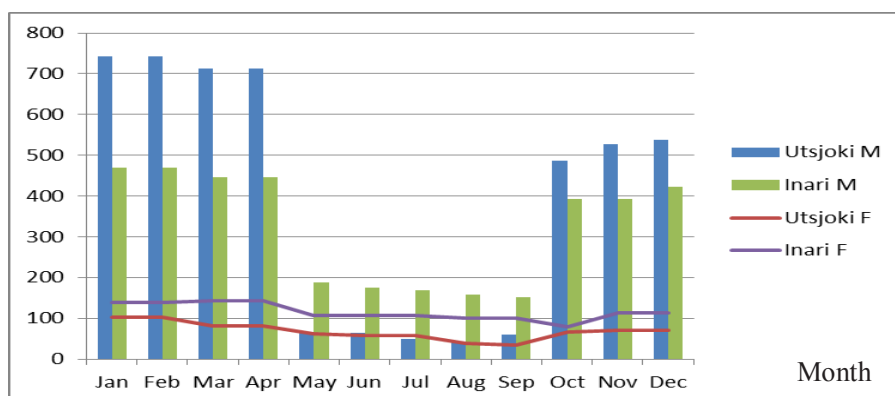


Figure 13. The consumption of reindeer meat (grams per person per day) by reindeer herding Sami in Utsjoki and Inari Sami (Fisher Sami) in 1960s in the individual survey (Jokelainen 1965). M=males, F=females.

Most of the energy is derived from cereal products in all Sami groups, but other foodstuffs change between the groups (Table 3). From the reindeer meat and fish comes little energy. Although the diet was composed of few foodstuffs and monotonous in the way it was prepared, it was quite good from the nutritional physiology point of view. The diets were found to provide sufficient energy, and the intake of protein, iron, thiamine and niacin was high. The calcium intake of the Skolts was low, and there was a slight deficiency in the intake of riboflavin in the summer diet. The intake of vitamin C was adequate in other groups, except for the nomadic Sami and the Skolts. (Jokelainen 1965)

Table 3. The percentage contribution of the different foodstuffs to the total energy in families of different Sami groups (Jokelainen 1965).

Foodstuff	Nomadic and settled reindeer breeding and Fisher Sami groups	Skolt Sami
	%	%
Cereal products	28.9 - 40.5	39.6 - 50.1
Potatoes, other vegetables and peas	3.9 - 5.5	3.1 - 5.5
Berries and fruits	0.9 - 1.9	1.0 - 1.6
Sugar	9.4 - 11.6	11.3 - 19.1
Margarine	12.3 - 16.8	15.5 - 21.1
Butter	0.2 - 5.1	0.5 - 2.3
Other milk products	8.8 - 29.5	4.4 - 5.8
Meat and meat products	3.0 - 14.6	3.5 - 11.4
Fish	2.3 - 7.1	1.2 - 3.3
Intake of energy, kcal	2755 - 3395	2595 - 2660

Hasunen et al (1975) studied in 1969 and 1970 the nutrient intake of adult Finnish Sami. They found the food consumption and intake of nutrients to be higher for the Utsjoki population (75% of them were North Sami) than for the Sevetijärvi Skolt Sami. There were strong seasonal variations in the intake of levels of most of the nutrients. The nutrient intake in the Utsjoki population seemed to be adequate as compared with recommendations in the literature. For Skolt Sami, most of the figures were less than the given norms. Of the energy the proteins contributed in Utsjoki 15–16 % and in Sevetijärvi 15–17%, the fats in Utsjoki 35–38%, in Sevetijärvi 29–36% and carbohydrates correspondingly 46–50% and 47–56%.

In 1971 and 1976, the food consumption of the population of Inari and Utsjoki was studied by Hasunen et al (1976) in order to establish whether there had been any changes in the dietary habits since the study in 1962. In 1971, 110 people and in 1976 66 people were interviewed about their diet. The diet and the choice of produce were found to be significantly dependent on the choice of lifestyle. The reindeer herding people of Inari included a lot of reindeer meat in their diet, whereas fish was the most common among the reindeer herding fishermen. The Inari people of other professions also used a lot of fish in their diet. The most important products in the Lappish diet were meat and meat products, grain products, fish, potatoes, milk and fats. The diet varied significantly between winter and summer. In the winter, the consumption of meat was high, whereas in the summer the consumption of fish was high. The consumption of meat and fish became gradually a year-round phenomenon when freezers became more common. The consumption of potatoes decreased, whereas the consumption of other vegetables as well as fruit and berries increased by comparison to the 1962 study. The Sami on River Teno had cows, and due to this, the consumption of milk increased since the 1962 study.

Hasunen et al (1974) made a dietary survey by the weighing method on 120 Finnish Skolt Sami children. The average energy intake varied in winter from 870 to 2,188 kcal/per day and in summer from 1,070 to 1,970 kcal per day in different age groups. The intake of calories and most nutrients were lower than the accepted norms. Children living at home were most unfavourably situated. School meals were quantitatively balanced and filled requirements for all nutrients except iron. The intake of vitamin C, calcium and vitamins of the B-group were low.

Lactose malabsorption among Sami is common. It is inherited by a single autosomal recessive gene (Sahi et al 1973). The frequency of that gene among North Sami is 0.58, and the prevalence of lactose malabsorption is 34% (Sahi et al 1976). The corresponding figures for Finns were 0.41 and 17%. The prevalence of Skolt Sami was 60% and Inari Sami 25% (Sahi et al 1974, Hasunen et al 1977). The Sami have been using cow milk for about 100–150 years and reindeer milk for about 300, but consumption has been very scanty. The Skolts used sheep milk already before they started to use reindeer milk (Itkonen 1948). The hypothesis that lactose

malabsorption affects food selection and nutrient intake, was studied among the Finnish Sami population in Inari in the summer of 1975 (Hasunen et al 1977). The total number of those interviewed was 282, 134 Inari or Fisher Sami, 82 North Sami and 66 Skolt Sami, Finns or ethnically mixed. There were no definite differences in dietary intake between the lactose absorbers or non-absorbers. Instead, there were significant differences in the dietary intake between the different Sami groups. It was concluded that the differences found in that study on dietary intake, are economic and cultural in origin rather than being caused by lactose malabsorption. Most of full-heritage American Indians are intolerant to lactose, but they can consume small amounts of milk and other lactose-rich products without symptoms of diarrhea and intestinal cramping (Newcomer et al 1978). In the 1960s, Skolt Sami used condensed milk from Norway. The milk powder was mixed with water when needed (Isensee Jaana 2001, personal communication).

In the study on reindeer herders (Hälinen et al 1993) in 1986, a 24-hour diet interview was conducted with 661 men. Seasons of the year had an effect on the composition of the diet. The diet included dark bread, meat in the winter and fish in the summer. However, vegetables, berries and fruit were little used. The reindeer herders from Mountain Lapland used less saturated fat and their P/S ratio (the ratio of polyunsaturated and saturated fats) was 0.26, when the mean was 0.18. Both were below the recommendations of the State Nutrition Committee of Finland (0.5–1.0). The intake of carbohydrates was under the recommended level, but the intake of protein was high, which is due to the frequent use of reindeer meat in the mountainous Lapland. That group had a low intake of vitamin A and calcium.

In 1993, the dietary habits of 44 mothers of pre-school children in the region of Enontekiö were studied with an interview (Vieltojärvi 1995). There were two groups that differed from one another based on the use of traditional foods. Those following a traditional diet had simple meals prepared with traditional methods using either reindeer or fish. The meals of the mothers not following a traditional diet were more varied. The methods of preparation varied more, and other meats in addition to reindeer were used. The mothers following a traditional diet used more margarine (Norwegian fish or vegetable margarine) in preparing the food.

During the years 1996–98, as a part of the AMAP/HH first phase, 151 pregnant women from 7 municipalities in the most northern and north eastern Finnish Lapland completed a questionnaire (FQ method) and kept a food diary (FD method) for seven days (Soininen et al 2002). The nutrient intake among these mothers was calculated by Nutrica, a nutrient calculating program from the Finnish Social Insurance Institute. In addition to foodstuffs, metals and other pollutants were estimated. According to this, for example, a mother's dietary mercury intake correlated to the mercury concentration found in her blood as a whole.

The protein proportion of total energy was 16.3 (FD) and 18.2 (FQ) energy per

cent (E%). The mean intake of protein was higher than recommended in Finland (10–15 E%). The fat intake energy was 30.3–36.0 E%. The fat intake estimated by food diary was a little higher than recommended in Finland (30 E%). The proportion of saturated fat from total energy was 13.1–16.2 E%, which is more than recommended (10 E%). The proportion of essential polyunsaturated fatty acids from total energy was 2.4–2.5 E%, which is less than recommended for pregnant women (5 E%). The proportion of carbohydrates from total energy was 47.6–51.3 E%, which is below the Finnish recommendations (55–60 E%). The fiber intake was near the minimum of recommendations.

The mean intake of vitamins D and E, thiamine and folic acid were below the recommendations. The average intake of sodium calculated as salt was 7.1–7.3 g/day, which is more than the recommended intake (5g/day). Iron intake from diet was low 10.1–11.4 mg/day, when the recommendation was 12–18 mg/day. The mean intake of heavy metals (mercury, lead, cadmium) when calculated from the concentrations in different foodstuffs was low. The mean intakes of zinc, copper, selenium were above the FAO/WHO's normative requirements.

The Finnish Radiation and Nuclear Safety Authority surveyed the use of berries, mushrooms, game, reindeer meat, and fish from 1 500 Finnish households in 1996. Less mushrooms were used in northern Finland (the provinces of Oulu and Lapland) by comparison to the rest of the country. However, more berries, game, and reindeer meat were used up north (Markkula et al. 1996). The Skolt Sami did not eat mushrooms. They were considered to be reindeer food (Isensee Jaana 2001, personal communication).

Reindeer meat

Reindeer as food is really versatile and healthy (Nieminen 1994, Hassan 2012). The Sami, who have their own reindeer, use them rather diversely still today. Those who do not have their own reindeer, buy the trunks without head and viscera or they buy separately meat, heart, bones etc. The consumption of reindeer meat seems to be high among the Sami (Jokelainen 1962, Hasunen et al 1977, Hälinen et al 1993, Soininen et al 2002, Brustad et al 2008). In the health study of reindeer herders, the reindeer meat consumption of the reindeer herders living in mountain Lapland (most were Sami) was 235 g/day when the mean of all reindeer herders was 76 g/day (Hälinen 1993). Sami mothers also ate a lot of reindeer meat. Half of 22 Sami mothers (1996–98) also ate elk meat, and all except one a lot of fish (Soininen et al 2002).

The protein concentration of reindeer meat is high, and it also contains essential amino acids (Nieminen 1994). The highest protein concentration is in the heart, liver

and thymus. There is plenty of unsaturated oleic acid (18:1) as well as saturated stearic-(18:0) and palmitic acid (16:0) in the fat tissues of reindeer. In the fall, the P/S ratio is high and even higher than in the fat of the elk or the white-tailed deer. The vitamin content of reindeer meat is high, most important are the several B-group vitamins. The concentrations of riboflavin and niacin are higher than those of the cow and pig. The reindeer liver includes a little vitamin C. The meat and liver also include vitamin E and vitamin A. The mineral elements and the trace elements, magnesium and potassium of the reindeer meat and viscera are high. There is a lot of iron, and the selenium, concentrations are 5–10 times higher than in bovine meat. There is much selenium (Nieminen 1994), especially in the liver.

Hassan et al (2012) also found that reindeer meat contained higher vitamin B12, iron, zinc and selenium concentrations when compared to Norwegian beef, lamb, mutton, pork and chicken meat. In Norway it was found that reindeer from districts with low animal population density had significantly higher selenium concentrations than those from districts with medium and high population densities. The concentrations of cadmium and lead and caesium isotope Cs-137 are low in Finnish reindeer meat today (Rintala et al 1995).

Fish

According the studies by Jokelainen in 1962, the consumption of fish was very high (Table 4) when compared to that of general population in Finland, which was in 2010 15.8 kg/ person / year (Finnish Game and Fisheries Research Institute 2013). Half of the male reindeer herders ate fish almost every day in the summer (Hälinen et al 1993). High fish consumption is beneficial because in addition to protein, vitamin and healthy oil acids, the selenium content in fishes is high.

g/person / day

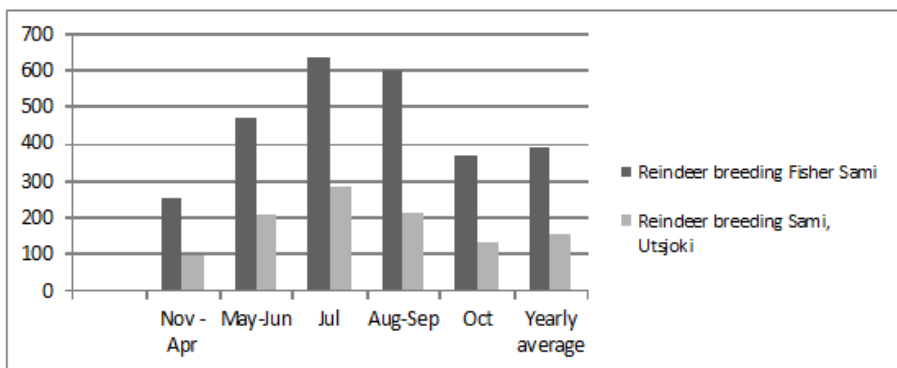


Figure 14. The consumption of fish (grams per person per day) by reindeer herding Sami men in Utsjoki and reindeer herding Fisher Sami men in Inari in 1960s in the individual survey (Jokelainen 1965).

Fish has been important food for every Sami group. Reindeer breeding Fisher Sami (Inari Sami) used the most fish around the year (Figure 14). The Sami got whitefish, trout, graylings, vendace, arctic char, and even perch and pike from the lakes. Salmon live only in the Teno River. Fish was dried, salted, cooked, fried and fat, spawn and milt extracted. Berries were often added to fish dishes.

Table 4. The yearly consumption of fish in different Sami groups in 1962 in Inari, Nellim and Utsjoki (Jokelainen 1965).

Subjects	g/person/day	Remarks
Inari		
Reindeer-breeding males	243	
Reindeer-breeding Fisher Sami males	389	Fisher Sami (Inari Sami) 142 kg/person /year
Other occupations males	140	
Reindeer-breeding females	133	
Reindeer-breeding Fisher Sami females	227	(Inari Sami)
Other occupations females	175	
Nellim		
Other occupations males	111	Skolt Sami 40 kg/person/year
Other occupations females	212	Skolt Sami
Utsjoki		
Reindeer-breeding males	151	North Sami
Other occupations males	156	North Sami
Other occupations females	164	North Sami

The Selenium content of Lappish people is seen in Appendix 4. It was studied in the 1980s and 1990s because of its protective function for increased mercury and other toxicants. It has also been found that low serum selenium levels among men were associated with an increased risk of cancer, with the strongest association observed for cancers of stomach and lung (Knekt et al 1990).

Other foodstuffs and water

Several kinds of birds were eaten in former times. The willow ptarmigan was the most important. It could also be sold. In Inari, a family could get 800–1500 willow ptarmigans (Itkonen 1948) in former times. Those are trapped still today and are usually sold as they were earlier.

Berries which the Sami have used and use still are cowberry, blueberry, bog bilberry, black crowberry and cloudberry. The last ones were often sold. The fat was often collected from fishes, game, reindeer and later used in porridge, bread

or mixed with bark. Inari Sami and Skolt Sami used bark by mixing it with several other foodstuffs, mostly for baking bread. Sugar has been used since the 1870s in Lapland. Since then, the Sami have used it more and more. (Itkonen 1948)

Plenty of coffee was used. An adult Sami may consume 1.5–2.0 litres per day (Jokelainen et al 1962, Hälinen et al 1993). Nowadays, the reindeer herding Sami still drink more than 7 cups per day on average (Brustad et al 2008). The Skolt Sami drink tea.

Because it was thought that the mineral content of drinking water affects morbidity, especially that from coronary heart disease and the existence of a “water factor is considered probable, Sahi et al (1978) studied the mineral content of drinking water in 31 well water and 30 surface water samples in Inari. They found the mineral concentrations very low, much lower than in other parts of Finland.

2.3.2 SMOKING

The Sami used to smoke a pipe already in the 17th century. Tobacco was often mixed with some local plant leaves (Itkonen 1948). Young people sometimes smoked moss like tobacco (Ahola 1975 personal communication). In the middle of the 20th century, mostly men smoked and only older women (Itkonen 1948). There are pictures where old Sami women were smoking a pipe. In the middle of the 19th century, the Skolt men did not smoke because of religious reasons (Itkonen 1948). They started later, but still in the 1960s and 1970s, Skolt women did not smoke (IBP/HA 1967–71). The Finnmark study 1978 showed that 50% of the Norwegian Sami men and 38% of the Sami women were daily smokers (Hermansen et al 2002). In the age group of 35–49 in the same Finnmark study, 66% of Sami men were smokers and 39% of women (Forsdahl 1978).

In the health study of reindeer herders in Finland (Näyhä et al 1993) in 1986, 33.8% of the reindeer herding Sami were smoking at that time. The corresponding non-Sami figure was 27.4%. In the Swedish study (Edin-Liljegren et al 2004) the number of daily smokers was somewhat lower among the Sami than among the non-Sami in the same region. In the FINRISK study (Berg et al 1990, Helakorpi et al 1999, 2005), the proportion of daily smoking men in the northern part of Finland was 41 % in 1989 and of smoking women 26%, when the figures for the whole country were 36 and 22%. In 1999 the smoking percentages were 22 for men and 24 for women, in the whole country 26 and 19. In 2005 the figures were 30% and 14% and for the whole country and 26% and 18% in the North. It looks like the northern people react a little later than people in other parts of Finland. Figure 15 (Helakorpi et al 2005) shows that daily smoking has decreased among men and increased among women in northernmost Lapland, Utsjoki. In that study, the Sami sample is not known, but may not be very large.

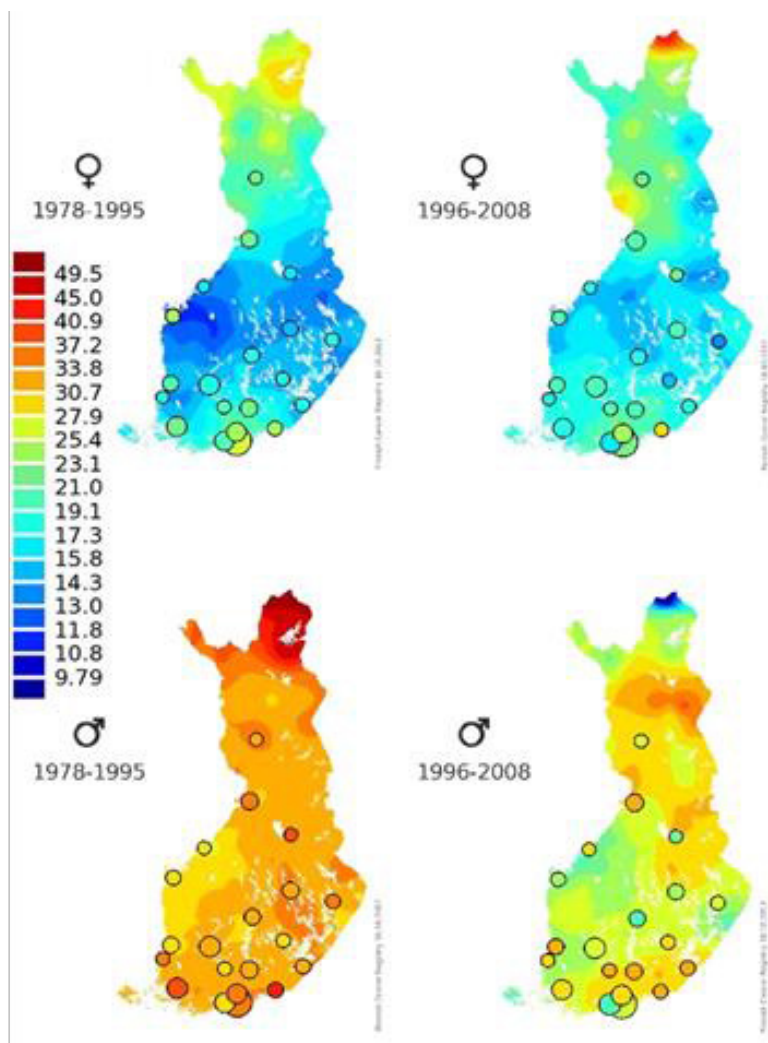


Figure 15. The percentage of daily smokers in the Finnish population. Two time periods are compared: 1978–1995 and 1996–2008. Maps are based on -specific data from “Health Behaviour and Health among the Finnish Adult Population” (Helakorpi et al. 2011, Patama 2013). The accuracy of the visual details is 2 km².

In Northern Lapland 30% (45/151) of mothers smoked before pregnancy and 60% (27/45) of them had quit smoking due to pregnancy (Soininen et al 2002). No difference was detected between the smoking habits of Sami mothers and non-Sami mothers. Young mothers smoked more than older mothers. Of the pregnant mothers, 13% (19/151) reported that they were exposed to ambient tobacco smoke at home.

Compared with mothers from other regions, mothers in Lapland smoked the most (Soininen et al 2002, Gissler et al. 2002). In 2000, 18% of the mothers in Lapland were smokers, whereas the percentage in the whole country was 12.6%.

The percentage of those who had quit smoking was 0.3% in Lapland and in the whole country 1.7%.

2.3.3 ALCOHOL

There are no comprehensive studies of alcohol use among the Sami. The Sami have not traditionally produced alcohol beverages. Already in the 16th century there were people, tax collectors and traders who brought alcohol to the Sami. It was easy to sell it to them or to exchange alcohol very economically, for example, for reindeer. There has been that kind of exchange trade until the 1980s. It has been told and written (Sariola 1954, Lindroth 1970, Hetta et al 1978), that even in the 20th century Sami men used a lot of alcohol during the time when reindeer were collected into the fence and inventoried and slaughtered. That may not differ very much from celebrations that people have in the southern part of Finland. Alcohol has also been used in marriage feasts and Easter time (Hetta et al 1978). In the mid-nineteenth century, the Laestadian revivalist movement played an essential and successful part in the crusade against alcoholism and alcohol consumption.

The sales statistics of municipalities of the National Institute for Health and Welfare are not telling the truth, because a lot of the alcohol sold in Utsjoki goes to Norway, and in Inari a part is bought by the tourists. According to the health study of reindeer herders, the alcohol consumption of the Sami reindeer herders was significantly higher than non-Sami reindeer herders in all age groups. The Sami, who had one Sami parent used 21.7 g alcohol per day, if both parents were Sami the alcohol intake was 19.5 and if one or more grandparents were Sami 19.1 g/day. If both parents were Finnish the intake was 11.4 (Poikolainen et al 1992). In that study, reindeer herders in the western part of Lapland (Enontekiö) used the most alcohol; on average 23.1 g/day. In the Inari-Utsjoki area, the intake was 14.7 g/day. The alcohol consumption of Sami women is not known. In the Finnish AMAP study, the pregnant women reported that they did not use alcohol at all (Soininen et al 2002). The consumption of alcohol was not more common among Sami than the non-Sami control group in Swedish CVD risk factor study (Edin-Liljegren et al 2004).

2.3.4 PHYSICAL ACTIVITY

The Sami have traditionally had a lot of exercise in their everyday living. Before roads, especially in summer, the way to move from place to another was to walk or go by boat or by horse. There were not many horses, and reindeer could be

used only for carrying packs, but not riding. Boats did not move without exercise. In winter, reindeer were also used as draught animals. There was a special skill in using the reindeer, and the training of reindeer for that purpose was also necessary. They had sledges, which horses also could have. (Itkonen 1948, Lindroth 1970)

Reindeer herding was very much exercise-demanding before snowmobiles. Snowmobile operating also needs a good physical condition, and when it gets stuck in the snow, a lot of power and very healthy back is needed. That means that active reindeer herders exercise still today if they drive in the woods or outside the trails. Näyhä et al (1991) sent a postal interview to reindeer herders and found that snowmobile operation is very strenuous and causes troubles in the limbs and back.

In almost every house there is at least one snowmobile, and they are also used a lot for short distances. Nowadays many have terrain vehicles, which they use in summer in the woods and mountains. That is different kind of exercise than walking. Otherwise, the Sami exercise like people in Lapland, picking berries, fishing and doing different kinds of sports.

In 1987–88 in Finnmark the physical activity of 866 Sami men and 860 Sami woman were compared to 4105 Norwegian men and 3948 Norwegian women and found that Sami men and women had a higher total physical activity score than Norwegian men and women (Hermansen et al 2002). In a Swedish cardiovascular risk factor study, the degree of physical activity was the same as the non-Sami reference group, but the reindeer herding Sami had more physical activity than the non-reindeer herding Sami (Edin-Liljegren 2004).

When the maximal oxygen uptake was used as a measure of physical cardiovascular fitness among arctic populations, it was found that only nomadic Sami and active hunters still living a traditional life had a high degree of maximal oxygen uptake superior to all settled Sami and Alaskan Inuit studied (Andersen et al 1962, Karlsson 1970, Sundberg et al 1976, Rode et al 1971).

2.3.5 BLOOD PRESSURE AND HYPERTENSION. INDICES OF KELA: Diseases of public health importance

Sundberg et al (1975) recorded the blood pressures in 221 Skolt Sami and 331 mixed Sami (Inari Sami and North Sami) over the age of 20. There were 147 men and 184 women in the mixed Sami population, and 103 men and 118 women in the Skolt population. In the group of mixed Sami were about 60% of the Sami living in the municipality of Inari 95% of all Skolt Sami. The systolic pressure was found to rise more with age in women than in men. In neither sex did age affect the

diastolic pressure. A general tendency towards higher blood pressure was noticed in the group of mixed Sami up to the age of 50–60 years, but not in the Skolt Sami group. Comparison with another Finnish population revealed similar systolic blood pressures in females, but definitely lower values in all male Sami.

The finding that the Sami did not have clear age dependence of the diastolic blood pressure as occurs in the Finnish general population supports the hypothesis that the setting of the resting blood pressure level is influenced by different kinds of stress associated with technological development and with an urbanized life (Sundberg et al 1975). In the mixed Sami group, the blood pressure was over 160/95 in 31 males and 59 females. The corresponding numbers of the Skolt Sami were 12 and 29. Hence, the prevalence of hypertonia in those groups in the same order was 21%, 32% and 12%, 25%. The lowest prevalence was in Skolt Sami men. The results are only directional because the age group 40–59 of mixed Sami was underrepresented.

The Sami reindeer herders had lower blood pressure than other reindeer herders and lower than non-Sami reindeer herders in the same region. 11.7% of the Sami reindeer herders had a physician-diagnosed arterial hypertension. (Näyhä et al 1993)

Diseases of public health importance

The municipalities and hospital districts can follow their health situation by comparing the prevalence of the diseases of public health importance to the corresponding figure of the whole country. That is carried out by calculating for municipalities the indice of the diseases (whole country =100). Kela has reported indices for diseases of public health importance since 1990. The diseases analysed are the seven most prevalent diseases for which special reimbursement for the medication is entitled. For each disease, the prevalence is calculated and linked to the average for the whole country. Diseases of public health importance are asthma, diabetes, rheumatoid arthritis, psychoses, coronary disease, cardiac insufficiency and hypertension (Kela Health barometer 2015).

(http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NIT083AL&YKIELI=E)

The hypertension indices (calculated of the entitled special reimbursement for the medication of hypertension) of the Inari and Utsjoki municipalities are seen in Figure 16. The indice of Lapland of there as comparison. The Inari and Utsjoki indices have been below the national average until 2005–2009. Thereafter they started to increase, and in the end in 2009 the indices have raised above the indice of Finland. The indice in Lapland has been on a higher level than that of Inari and Utsjoki and has begun to increase in the same way already in about 2000.

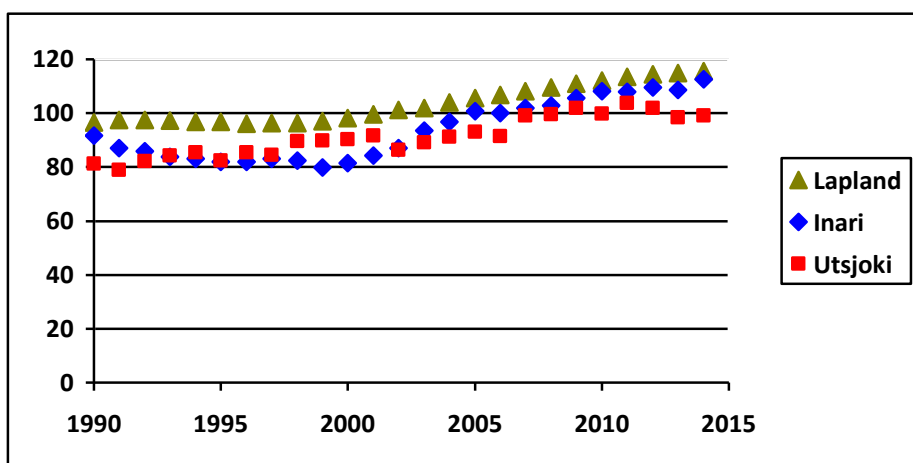


Figure 16. Indices¹⁾ of arterial hypertension of Inari and Utsjoki and whole Lapland in 1990–2014 as compared to the annual rate in Finland (100) (Kela Health barometer 2015). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1)

¹⁾The description of the indice is in chapter 2.3.5.

http://raportit.kela.fi/approot/lisatied/NIT083A_en.html

http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NIT083AL&YKIELI=E

Edin-Liljegren et al (2004) studied the blood pressure of Swedish reindeer-herding Sami and non-reindeer herding Sami and compared their blood pressures to those of the age, gender and area of residence adjusted non-Sami. There was not much difference between the Sami and non-Sami. The systolic blood pressure of the Sami was 126 mmHg and that of the non-Sami 128, and the corresponding figures for diastolic blood pressures 78 mmHg and 79. There was more difference between reindeer herding Sami men and non-Sami men. The systolic/diastolic blood pressures were 127/78 and 134/83 mmHg respectively.

2.3.6 BLOOD LIPIDS AND ANTIOXIDANTS.

The cholesterol and triglyceride concentrations of the Sami were studied in 828 Sami. The samples were taken in July and August in the years 1969 and 1970. The serum levels of concentrations of the cholesterol and triglycerides as compared with those of Finnish rural population were the same (Björkstén et al 1975). There were also no differences between the Sami groups (Aromaa et al 1975). Neither was much difference in total cholesterol found among Swedish Sami and non-Sami (Edin-Liljegren et al 2004). The concentrations of serum cholesterol and LDL cholesterol were higher among Sami reindeer herders than non-Sami reindeer herders in 1989. In serum HDL cholesterol, there was no difference (Luoma et al 1995).

Later studies have found that low-density lipoprotein (LDL)-cholesterol, apolipoprotein B, high-density lipoprotein (HDL)-cholesterol and triglyceride levels did not differ between the Sami and the non-Sami reindeer herders (Lehtinen et al 1998). In the same study it was found that the Sami reindeer herders had a higher frequency of the apoA-IV-2 allele than the Finns and other studied populations.

Antioxidants and selenium.

Luoma et al (1995) have studied the serum alpha-tocopherol, albumin, selenium and cholesterol concentrations of Sami reindeer herders. Alpha-tocopherol concentration increased with the consumption of reindeer meat, and serum selenium increased with fish consumption. The favourable serum antioxidant status among reindeer herders was thought to be credited to the local diet and hence there were not differences between Sami and non-Sami. The good antioxidant status was connected to the low mortality from cardiovascular diseases in spite of high cholesterol concentrations in the blood. In Appendix 4, the selenium concentrations of different arctic people and cord blood of neonates are seen. There is rather much variation. Highest mean value is in cord blood of Greenland neonates.

2.3.7 WEIGHT

According to WHO guidelines, the normal body mass index (BMI, kg/m²) is between 18.8–24.99 kg/m² and overweight 25–29.99 kg/m² and obese over 30 kg/m³. The Sami and the Norwegians in Finnmark have a normal weight index. The Finns in Finnmark (Forsdahl et al 1979) and both Sami and non-Sami reindeer herders were overweight (Näyhä et al 1993). The same concerns Swedish Sami (Edin-Liljegren et al 2004), (Table 5). In the study of Jokelainen in 1962, the women of the settled North Sami and nomadic North Sami were a little overweight.

Table 5. The mean body mass index kg/m² of adult populations, the Sami, Finns and Norwegians in Finnmark (Forsdahl et al 1979), reindeer herders (RH) in Finland (Näyhä et al 1993) and Swedish reindeer herder-, non-reindeer herder Sami and their control group (Edin-Liljegren et al 2004), Sami of the SAMINOR study and the Finns (Borodulin et al Finriski 2012).

Ethnicity	Males		Females		Both genders		Reference
	N	BMI Mean kg/m ²	N	BMI Mean kg/m ²	N	BMI Mean kg/m ²	
North Sami nomads	47	24.1	19	26.5			Jokelainen 1965
Inari Sami	16	23.1	6	23.7			
Skolt Sami Nellim	10	23.0	6	24.7			
North Sami	28	23.0	13	25.1			
Sami in Finnmark	990	24.8	976	25.4			The Cardiovascular Study of Finnmark 1973-74 age group 20-49 years (Forsdahl et al 1979)
Finns in Finnmark	1241	24.8	1211	24.5			
Norwegians In Finnmark	3408	24.2	3230	23.4			
RH Sami men in Finland	31	25.5					Näyhä et al 1993 12% had BMI>30
RH Sami Sweden	93	25.8	77	26.2			Edin-Liljegren et al 2004
NRH Sami Sweden non-Sami Sweden	183	26.2	258	25.1	1222	25.7	
SAMINOR Norway					40	<18.5	Brustad et al 2007
SAMINOR Norway					3608	18.5-24.9	
SAMINOR Norway					5818	25-29.9	
SAMINOR Norway					3322	≥30	
Finns		27.1		26.2	5834		Borodulin et al 2012

NRH = Non-reindeer herding Sami, RH = Reindeer herding Sami

There was not a significant difference between Sami and non-Sami reindeer herders in spite of among the Sami there were less those who had the BMI above 30 (Näyhä et al 1993).

In Table 5 the BMI of different Sami and non-Sami groups in different times are compared. There is a trend upwards from 1960s, when only North Sami women were overweight.

2.3.8 STATURE OF THE SAMI

When the measurements from 1966–1970 were compared to measurements published by Näättänen 1936, it was shown that the height of native Skolt Sami had

increased markedly (Lewin 1971). Näätänen has measured in 1926–1934 the height of 795 Sami in Inari, Utsjoki, Enontekiö, Sodankylä and Petsamo. The stature of Inari Sami was 161.1 cm, North Sami 162.2 and of Skolt Sami 157.7. Schmakoff (1904) got as main stature of Skolt Sami men and women 154.3 in 1895–96 (Näätänen 1936). In Figure 19 are the main statures of Sami in Inari and Skolt Sami males compared with the statures of Eastern and Western Finns.

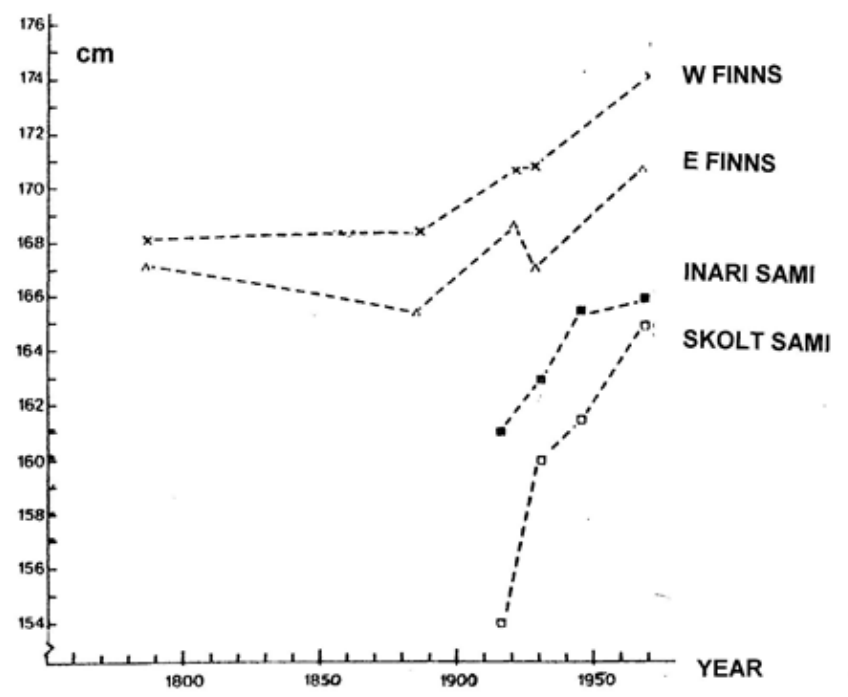


Figure 17. Stature in males (cm) among Sami in Inari (Fisher Sami and North Sami) and Skolt Sami from 1930 to 1966. As comparison to Western (W) and Eastern (E) Finns from 1800 to 1966 (Näätänen 1936, Nickul 1948, Eriksson 1974)

2.4 THE HEALTH CARE ORGANIZATION

2.4.1 PRIMARY HEALTH CARE

The system of health care is in Inari and Utsjoki in principle the same as in other parts of Finland, being determined by the Finnish legislation starting from the constitution. The basic principle is: health care is a basic right of every citizen, and the authorities are responsible for ensuring its availability. The costs for people are so low that everybody can use the health services. Local authorities shall implement

healthcare services according to Health Care Act (1326/2010), Public Health Act (66/1972) and the Act on Specialized Medical Care (1062/1989). There are some special challenges because the area is wide, 20,000 square kilometres, with the population is sparsely distributed and the distances long; that from Nuorgam to the health centre in Ivalo being 210 km and that from Ivalo to the Central Hospital of Lapland in Rovaniemi 300 km.

Until 1994 from 1924 Inari and Utsjoki had a common health care system and most of the time common medical doctor(s) (Yliruokanen 1981). The medical doctor was located in Inari in the beginning and later on in Ivalo. Inari village was earlier the centre of the municipality. Public health nurses have been located in all villages, even in small remote villages. First they were in Utsjoki, and later in Outakoski and Karigasniemi. In Inari municipality: Inari village, Sevettijärvi, and Nellim and. The health station of Utsjoki is the eldest “health building” still used today.

Because the distances are long, cars are necessary. Today most people live close to roads. When the sickness insurance act came into force in 1964, the need for travelling to the medical doctor was recognized by the state. From that time on, it has been possible to get reimbursement for travelling costs. For those who lived far from services (health centre, shops, banks etc.), it was practical to also manage other things such as shopping when coming to visit the doctor. Hence, the threshold to visit the doctor was rather low, similarly for the Sami and non-Sami from the Northernmost Finland (Kirjarinta 1977).

Airplanes and helicopters have been very useful in emergency cases when flying is possible because of the weather or the situation of the vehicle. The Border Guard has had a helicopter in Ivalo from 1960 and another from 1974 in Rovaniemi (Pesonen 1977). There have been private airplanes since 1960 in Inari. From 1967 to 1969 there were about 40 flights because of diseases or accidents, which the Border Guard operated. The helicopters of the Border Guard were moved away from Ivalo in the 1980s.

The contacts to northern Norway have always been very close, especially along the Teno valley, and thus some of the health services, dental service and veterinary services in Utsjoki were until recently supplied from Norway. The x-ray screening of tuberculosis was done by the Norwegian health care system during 1960–1971 (Forsdahl 1981). Finland, Sweden, Norway and Russia have contacts and contracts for emergency situations, and it is possible to get help from the neighbour country if they have a helicopter near the border.

The first District Hospital started in Ivalo in 1947. Its name was changed in 1951 to the Inari local hospital and in 1973 to the Inari-Utsjoki health centre. From 1994 Inari and Utsjoki had their own health care and hospitals or health centres and staff. The Inari health centre was built in 1973. At that time it was modern with versatile equipment. It had 40 beds, including 6 beds for women in childbirth,

laboratory, x-ray facilities, a department for physiotherapy and an operating room. (Kirjarinta 1977).

Children are no longer born in the Ivalo health centre. Mothers have to travel early enough to Rovaniemi Central Hospital. In connection with the Central Hospital, there is a patient hotel where the mothers can stay and wait their time. In Utsjoki, there is also a small hospital with consulting rooms for the physicians, laboratory and 12 beds. There are no x-ray possibilities, and people have to travel to Ivalo if needed.



Figure 18. Health care units in Inari and Utsjoki. The public health nurses (PHN) work in small health clinics (A) in Ivalo, Inari, Nellim, Sevetijärvi, Karigasniemi and Utsjoki. The figures mark the distances by road (km). Earlier there has been a clinic also in Outakoski and own PHN.

The distances on the area of Inari and Utsjoki and Rovaniemi.

Utsjoki - Nuorgam 43 km	Ivalo - Karigasniemi 158 km
Ivalo - Nuorgam 200 km	Ivalo - Sevetijärvi 156 km
Ivalo - Näättämo 200 km	Nuorgam - Rovaniemi 500 km
Ivalo - Rovaniemi 300 km	

The health service of Inari-Utsjoki employed 108 persons in 1977. There were among others 4 physicians, 4 dentists, 1 veterinarian, 14 public health nurses, 12 nurses, 14 assistant nurses, 2 midwives, 1 pharmacist, 1 psychologist, 2 physiotherapists, 2–3 health visitors (Kirjarinta 1977). In 1993 the federation of Inari-Utsjoki was annulled, and both municipalities organized their own health and social care. Services that Utsjoki cannot organize by itself are bought from Inari.

Today the health and social welfare administrations in Inari municipality are combined, and there are altogether 260 persons working with 150 persons in health (Inari municipality 2013).

In Inari, Sevettijärvi, Nellim, Kariganiemi, Nuorgam, earlier also Outakoski there are houses where public health nurses work in preventive health care and consult some patients, take control laboratory examinations or blood pressures. These “small clinics” form a network, which is near people and important because the distances are long. The public health nurse can give first aid for many health problems. They make home visits, but they also have certain days when they hold a clinic for children and their parents and expectant mothers and elderly people. A general practitioner has consulting hours 1–2-times per month in those remote “clinics”. (Soininen 1981)

There was already in the 1970s a tele-electrocardiogram system, by which the public health nurse could send the electrocardiogram of the patient with chest pain by telephone to the physician in Ivalo and then get orders what to do. The telephone as such was very useful, and because the patients and their diseases were familiar to the doctor, many times the order could be given by telephone (Soininen 1979, 1986). A private pharmacy is located in Ivalo, but not in Utsjoki. The pharmacy sends medicines to people by bus or via post. Prescriptions are electronic nowadays, but earlier they were done by telephone.

When a person is very sick, the transport should be fast and even. During the year 1989–1990 the flights in the province of Lapland were analysed (Soininen 1990). There were altogether 26 flights, from which 11 were in July. Most (15) transports occurred in the Inari municipality and most (15) between 4 p.m. and 8.00 a.m. Almost all cases were sudden illness attacks or accidental injuries, only 2 were pre-planned illness transports. Sometimes the helicopter could take the physician from Ivalo, and the care of the patient could be started already at the place of the accident. Now the nearest helicopter is in Sodankylä 160 km south from Ivalo.

2.4.2 THE SECONDARY HEALTH CARE OR SPECIAL CARE

The nearest hospital with specialists is in Rovaniemi, the Central Hospital of Lapland. It has 19 different special medical units and supporting units (laboratory, radiology, pathology, pharmacology etc.). The cooperation with special care and primary health care is close in spite of long distances.

2.5 DISEASES OF THE SAMI

Earlier biological studies among the Sami appear to be of only anthropological character (Wessel 1911–1918, Näätänen 1936). Some information about general health status, dental status and mortality is found in other literary contexts concerning the Sami (Tanner 1929, Forsdahl 1976). With the exception of Melbin (1962), who studied of the growth and health status among Lapp children in Sweden, there was a lack of medical population studies among Sami (Lewin et al 1971). The interest in Sami diseases started from the 1970s when the circumpolar cooperation of health researchers began. Thereafter a lot of studies of Sami have been published.

2.5.1 THE MORBIDITY INDICES OF KELA FOR MUNICIPALITIES IN FINLAND

Based on an indice value calculated for each municipality in Finland, this indicator describes the health or ill health of the local population in relation to the average for the country's total population (=100). Values standardised for age and gender are shown. The morbidity indice is based on three statistical variables: mortality, the proportion of disability pension recipients in the working-age population (ages 16–64) and the proportion of people entitled to drug reimbursements on medicines in the total population. Each variable has been calculated in proportion to the average for the country's total population. The morbidity indice is the average of the three sub-indices (Kela Mortality indice and Morbidity indice. NTO79A).

(http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NITo79AL&YKIELI=E)

According to the Indice of the Social Insurance Institution, the general morbidity in the Inari municipality has been about the same level as in Lapland since 1990. The general morbidity of Utsjoki has been mostly below the indice of Finland and Lapland (Figure 19). The percentage of the Sami in Inari is about 30 and in Utsjoki 70 until 2000, there after 60 (Appendix 1).

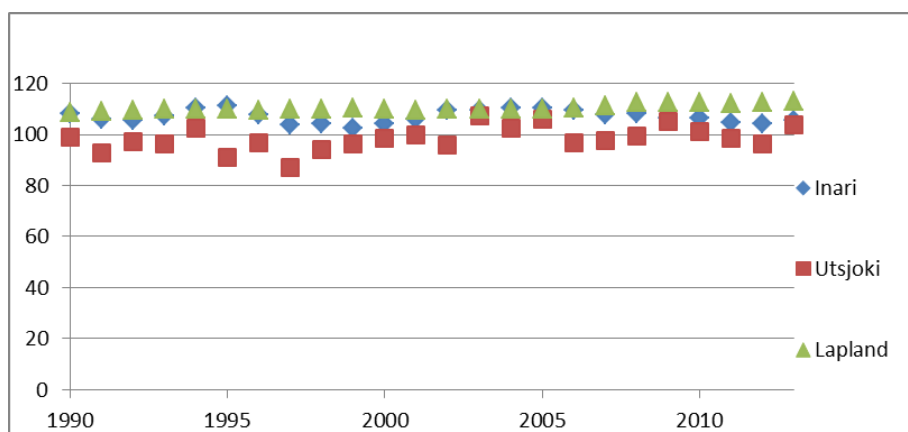


Figure 19. The morbidity index¹⁾ of Inari and Utsjoki municipalities and Lapland 1990–2013. The index of Finland is 100. The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1).

¹⁾The morbidity index is explained in the beginning of this chapter 2.5.1.

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http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NIT079AL&YKIELI=E .

2.5.2 CANCER

In the 1800s the only reference to cancer among Sami was found in the yearly reports of the Swedish physician Johan Ångström. He was the provincial physician in South Lapland in Sweden in 1853–1868, in a large district with 13,000 inhabitants, including 1000 Mountain Sami. Cancer was not common at that time (Ångström 2012).

The Finnish Cancer registry has published animations in which the spatial interpolation of the incidence rates are used (Pukkala et al 2001). They illustrate very well the development of cancer in areas of Finland. The scarce population in the North makes the statistic presentation a little problematic as seen from the white stripes in Figure 20.

Rates for 20 of the most populated cities in Finland are shown as circles with a diameter relative to the population size. A colour shading of the circles indicates the incidence rate in that city. The remaining rates are shown as floating averages of several neighbouring municipalities. The rate for each grid (size 2 x 2 km) on the map was defined as a weighted average of the age-adjusted incidence rates in the municipalities, with population centres within 200 km from the centre of the grid. The weights were inversely-associated with distance; the weight being halved where the distance was 25 km, the weights were made directly proportional to the sizes

of the populations within the 200 km circle. The northern parts of Finland are so sparsely populated (less than 1 inhabitant per km²) that even the interpolated rates are prone to a high degree of random variation. A white lining was superimposed on the colours of these areas to reduce emphasis on the underlying rates.

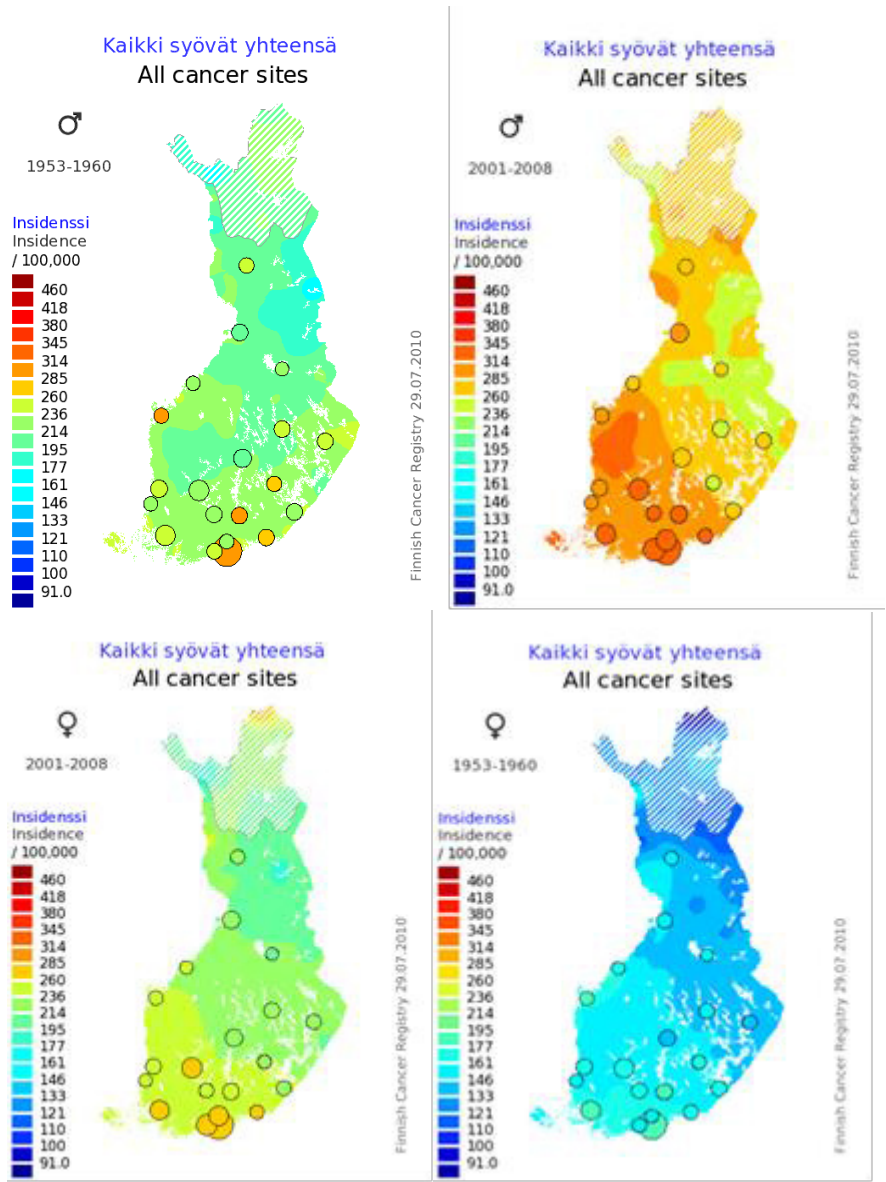


Figure 20. Cancer incidence of men and women in Finland 1953-1960 and 2001-2008 (Pukkala and Patama 2010). The map is based on municipality-specific data. The accuracy of the visual details is 2 km².

The first cancer risk study of the Sami was carried out during the period 1961–1984 in a cohort of 2,034 Swedish reindeer-breeding Sami (Wiklund et al 1990). A total of 100 cases of cancer were observed versus 163 expected, standardized incidence rate (SIR) was 0.61, 95% confidence interval (CI) 0.05–0.75. Statistically significantly decreased risks were found for cancers of the colon, respiratory organs, female breast, male genital organs, and kidneys, and for malignant lymphomas. The stomach was the only site with a significantly increased risk. Reindeer-breeding Sami have ingested fallout products via the lichen-reindeer-man food chain since the 1950s. However, no increased risk was found for the cancer sites considered to be most sensitive to radiation. In this study, the reference population was the Swedish total population. The non-reindeer breeding Sami were not included in this study.

A later cancer study of the Swedish Sami concerned cancers during 1961–1997 (Hassler et al 2001). There were two cohorts, one from the year 1960, the reindeer breeders with their family members, and the other cohort from 1980 were reindeer breeders with their family members. There were also geographically matched reference groups for both cohorts. The cohort from 1960 showed a statistically significantly lower total cancer risk in comparison to the Swedish general population in 1961–1997. The risk was lower both for men (SIR 0.56, 95% CI 0.47–0.67) and women, (SIR 0.68, 95% CI 0.53–0.86). A significantly decreased risk was found for cancer of the colon, respiratory organs, female breast, male genital organs, kidneys, urinary bladder, skin cancer and for malignant lymphoma. A statistically significant increased risk was only observed for stomach cancer. An interesting point in the study was that the cancer risk in relation to the general Swedish population was significantly higher among those Sami people who moved outside the reindeer herding area than within the remaining population that stayed on the Sami area. The SIR for such migrates was 1.63 (95% CI 0.95–2.62) and the SIR for the non-movers 0.55 (95% CI 0.45–0.67). The non-Sami reference group from the same region did not have such a difference related to migration.

The overall cancer risk was 40% lower among the reindeer breeding Sami than among the Swedish general population, and the cancer risk was 20% lower than the risk of the non-Sami population in the same geographical area. When the two calendar periods 1961–1980 and 1981–1997 were compared, no statistically significant differences in the risk to get cancer at various sites were found. Stomach cancer had decreased, but cancer of male and female genital organs and respiratory organs had increased a little. (Hassler et al 2001). The results were parallel with former results (Wiklund et al 1990). No excess of the cancers connected with radioactivity was found.

Hassler et al (2008) have studied the cancer of Swedish Sami in relation to lifestyle and genetic factors by an earlier constructed cohort of the Sami population from different registers of Sweden: Occupational register (reindeer herders), National Kinship Register of Statistics Sweden (the relatives of reindeer herders)

and Electoral registers of the Sami Parliament of 1993 and 1997. The number of Sami in this cohort was 41,721 persons. The demographically similar reference population consisted of 144,930 non-Sami (NS). The Sami were dealt further to reindeer herders (RS) and non-reindeer herders (NRS).

Most of the differences in cancer risks observed in that study were ascribed to differences in lifestyle between Sami and NS, between RS and NRS and between Sami men and women

The lowest relative risk was found among reindeer herding Sami men. The non-reindeer herders had only marginally a lower incidence than the men of the reference group living in the same area. The highest relative risk was found among NRS women. In the total Sami population there was a statistically significant trend over the follow-up period towards increasing relative risks for developing cancers of the stomach (both men and women), the breast (women only) and for leukaemia (men only). It was stated that the historically low cancer risks among the Sami have declined over the last decades, at least among the Sami women. It was thought that traditional Sami lifestyle holds several factors such as, e.g., high intake of reindeer meat and wild fish rich in selenium, vitamin A and omega 3-fatty acids, and low consumption of dairy products.

Cancer of the Norwegian Sami was studied in 1970–1979 in 3 northernmost counties of Norway. The cancer risk was low when compared with the regional reference population. The standardized incidence ratio (SIR) for men was 0.78 (95% confidence interval (CI) 0.73–0.84) and for women 0.84 (0.78–0.91). The risk was still lower when compared with the Norwegian general population. The SIR for men was 0.71 (0.66–0.76) and the SIR for women 0.73 (0.67–0.79). The risks for all cancers were low, except oesophagus cancer among men. There was no excess of the “radiation cancers” among those who ate much reindeer meat. (Haldorsen et al 2005)

Kurtio et al (2010) studied (after the cancer study in this thesis) the radiation doses from global fallout and cancer among Sami and non-Sami who were born and living in the Sami area. The standardized incidence ratios (SIR) of the cancers in 1971–2005 were calculated by using the number of cancers among the population of Oulu University Hospital district as reference. All SIRs of all cancer sites and radiation related cancer sites were significantly lower than generally in northern Finland. The SIR for all cancer sites among Sami was 0.60 (0.50–0.71) and of radiation-related cancer sites 0.47 (0.37–0.60). The SIRs of non-Sami were also decreased 0.88 (0.84–0.91) and 0.84 (0.80–0.88) respectively. The cumulative radiation doses were calculated according to the whole body measurements made yearly from 1961. There were 4 groups of doses from 0–0.9 mGy up to over 10 mGy. No correlation to radioactive dose could be found. When the doses that accumulated during the first 15 life years of were calculated and correlated to the SIRs of the radiation-related cancers, it was found that the stomach cancer risk increased with

an increasing dose and a small increase in the SIR could be found in all cancer sites and in radiation - related sites. The writers recommend dealing with the results with caution, because the radiation dose concerns only cesium-137 and not the other radionuclides, and stomach cancer is a target of multiple aetiology.

2.5.3 CARDIOVASCULAR DISEASES

Mortality from cardiovascular diseases (CVD) in 1960–1980 (Näyhä 1987) and 1960–1990 (Näyhä 1997) in Finnish Lapland has been generally high in some municipalities, but low in Sami municipalities.

During the period 1961–1990 male mortality from IHD was 41% lower in the predominantly Sámi area (Utsjoki) and 37% and 24% lower in two partially Sámi areas (Enontekiö and Inari, respectively) than in the purely Finnish reference area (Kittilä). The corresponding differences for females were 47%, 36% and 19% (Näyhä 1997).

Mortality from cardiovascular diseases among Swedish Sami men did not differ from the CVD of demographically matched reference population (Hassler et al 2005). The corresponding SMR of Sami women was significantly increased, 1.12 (1.05–1.20). The same was concerning ischaemic heart disease among men and women.

The indice of coronary disease (Kela Health Barometer 2014) began to increase in Inari first in the middle of the 1990s, but thereafter the tendency has been upwards. In Utsjoki that disease seems to have been always rare and is still below the national average (Figure 21).

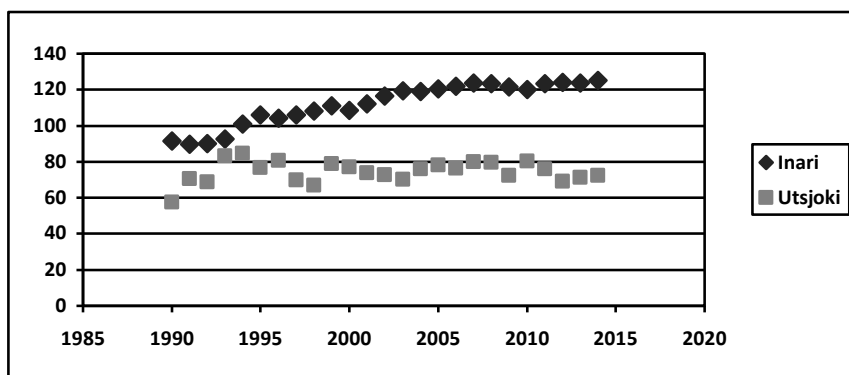


Figure 21. Indice¹⁾ of Coronary disease of Inari and Utsjoki in 1990–2014 as compared to the annual rate in Finland (100) (Kela Health barometer 2015). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1)

¹⁾The description of the indice is in chapter 2.3.5.

http://raportit.kela.fi/approot/lisatied/NIT083A_en.html

http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NIT083AL&YKIELI=E.

The cardiovascular study of Finnmark 1974–1975 (Forsdahl et al 1979, Bjartveit et al 1979, Thelle et al 1979) was a cardiovascular survey that was not planned to be a Sami study, but because some municipalities of Finnmark are the Sami municipalities, the Sami were included in the survey and their ethnicity was asked. The Sami had fewer cases of previous infarction than were to be expected and as many diabetes as were expected. Sami males had less hypertension and Sami females more than expected. The Finnmark study was repeated in 1977–78 and followed with respect to death for an average of 15 years (Tretli et al 1985). The mortality from coronary heart disease was lower in men who reported being of Sami origin than in men who reported Norwegian origin at both screenings. The SMR for cardiovascular deaths for Sami was 0.42 (0.25–0.73) and for Coronary deaths 0.38 (0.20–0.71). The reference population was the local non-Sami Norwegian population.

2.5.4 DIABETES

Diabetes has been very uncommon among Sami in Finland. The Skolt Sami did not have diabetes at all and still in the 1970s there were only a few cases among other Sami (Kirjarinta et al 1976). The Kela indices of diabetes in the Inari and Utsjoki municipalities are still below the Lappish and national average (Figure 22.). When the cardiovascular study of Finnmark- cohort was followed 15 years, the Sami women were more obese but did not have a higher diabetes mellitus incidence than other women. After adjustment for major cardiovascular risk factors and height, most ethnic differences were attenuated (Njølstad et al 1998).

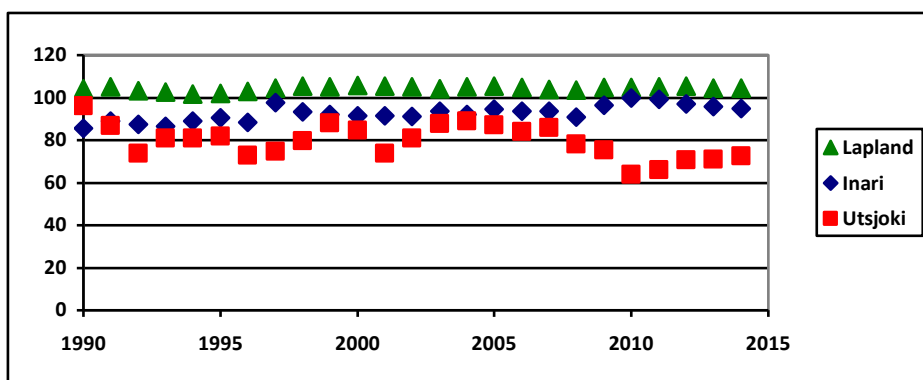


Figure 22. Indices⁹⁾ of diabetes of Inari and Utsjoki and whole Lapland in 1990–2014 as compared to the annual rate in Finland (100) (Kela Health barometer 2015). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1)

⁹⁾The description of the index is in chapter 2.3.5.

http://raportit.kela.fi/approot/lisatied/NIT083A_en.html

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2.5.5 DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE

Rheumatoid arthritis (RA)

RA has been suggested to be possibly of recent origin and associated with some unidentified environmental change (Sievers et al 1981). The diagnosis is defined by Rome criteria. In Lapland the diagnosis is usually confirmed by a specialist in the Central Hospital. RA has been studied in Tromsö, Northern Norway, which is an old See Sami area, but Sami are now a minority there. The total annual incidence rate for the period 1987–1996 was 28.7/100,000 personyears (py) (36.0/100,000 py in women and 21.4/100,000 py in men). No significant difference in incidence rates was found between the periods 1987–1991 and 1992–1996. The total prevalence of RA was 0.4% in 1989 and 0.5% in 1994. The corresponding data for women and men were 0.5% and 0.2% in 1989, and 0.6% and 0.3% in 1994, respectively (Riise et al 2000). Those Norwegian figures are lower than the corresponding prevalence and incidences generally in Finland, where the prevalence of RA was 1.6% in 2005 (Klaukka et al 2006). The annual incidence among Finnish women in the 1970s was 53/100 000 py and among men 29 /100 000 py.

In Utsjoki municipality, RA has been clearly more common than in Finland in general, but it is decreasing from 2008. The opposite happened in Inari a little earlier (Figure 23). One could think that the high indice is in connection with the Sami in Utsjoki.

High incidences are found in the unpublished data from the health centre files in Inari-Utsjoki in 1960–1978. The annual incidence for the North Sami was 94/100 000 person years (py), for the Inari Sami 86, for the Skolt Sami 38 and for the mixed group 81/100 000 py. The highest incidence was among North Sami women, 134/100 000 py. Figures are age and sex adjusted to the Finnish population. (Soininen unpublished)

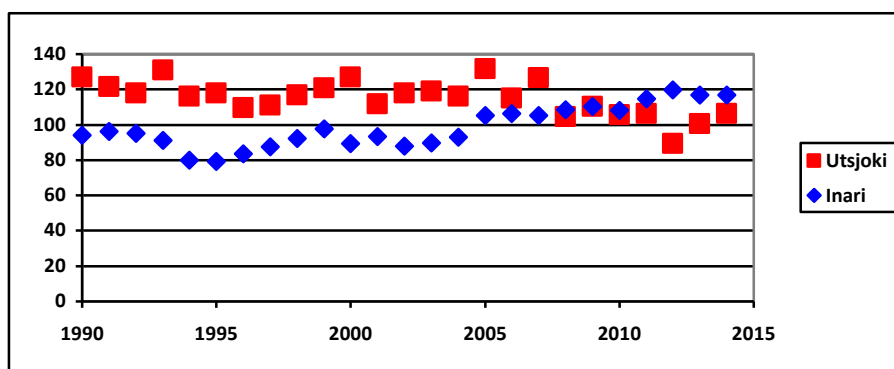


Figure 23. Indices¹⁾ of rheumatoid arthritis of Inari and Utsjoki and whole Lapland in 1990–2014 as compared to the annual rate in Finland (100) (Kela Health barometer 2015). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1)

¹⁾The description of the index is in chapter 2.3.5.

http://raportit.kela.fi/approot/lisatied/NIT083A_en.html

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Ancylous spondylitis and anomalies in the lumbar region

Among the Sami population in Karasjok and Kautokeino in Northern Norway, the prevalence of ancylosing spondylitis was 1.8% in 1987. 24% of them were HLA-B27-positive, which is connected to spondylarthroses (Johnsen et al 1992). The prevalence of ancylosing spondylitis is 1% in Finland (Viitanen 2000). Ancylosing spondylitis has been studied among Canadian Indians e.g. Haida, whose prevalence is 4–6% (Gofton et al 1966). The activator of the disease is in several cases infection, often gastrointestinal or venereal, like in Reiter's syndrome in Greenland among inuits (Bardin et al 1985). The prevalence of ancylosing spondylitis of Inupiat Inuits in Alaska was only 0.2%. It was less than expected in a population with a high percentage of HLA-B27 positive individuals (Boyer et al 1988).

Anomalies in the lumbar region are also considered to be common among the Sami. Schreiner (1935) reported spondylolysis in 13.8% of 296 Sami skeletons. This is considerably more than the 4–5% that is stated to be the frequency of other Scandinavians (Schmorl et al 1968). As regards other joint conditions in the 1930s, it has been asserted that osteoarthritis is of rather common occurrence among the Sami, while chronic polyarthritis (RA) is said to be very rare among them (Ekvall 1940). The study of Ekvall is like to be more what was seen among the Sami than a real study of RA.

Congenital dislocation of the hip (CDH), developmental dysplasia of the hip (DDH), luxatio coxae congenita (LCC)

Linné already noted in 1732 that the Sami walked as if they suffered from dislocated hips. He was also very engaged by the fact that they showed great stamina and were very agile and athletic (Forsdahl 2000). In 1918 A.B. Wessel, district physician in Sør-Varanger, Northern Norway, published an article titled “Limping families in the county of Finnmark”. Based on his own investigations, he concluded that the congenital dislocation of the hip joint was a hereditary disease, and that the prevalence of the disease was high in the Sami population, especially among Sami women (Wessel 1918, Forsdahl 2000). That may have been the first medical publication concerning the Sami. The dislocation of the hip causes asymmetry in walking, hence muscular discomfort and later arthrosis of the hip joint, which is very painful and causes difficulties in walking. The prevalence of developmental dysplasia of the hip (DDH) is about 1 per cent of all newborns (Schlenzka 1991). DDH is a congenital condition with dislocated, dislocatable, or subluxatable hip (Harila et al 2012). Today all newborn children are screened for early detection of hip dysplasia.

Wessel (1918) found that 27% of the examined (236 persons) Norwegian Sami had congenital hip luxation. Among the Swedish Sami girls, the frequency was 4.7 (Mellbin 1962). The Skolt Sami do not have this disease (Wessel 1918). When congenital dislocation of the hip of Sami in Inari was studied in 1966–70, Inari Sami and North Sami women had the highest frequencies; 12 cases/131 studied and 4/78 respectively. Skolt Sami from Sevettijärvi had no cases. Nellim Skolts had one. Altogether 2 men with CDH was found from 190 Inari and North Sami examined (Eriksson 1988).

Early hip dysplasia can be treated using different kind of harnesses, pillows and splints during the first year of life usually with good results. According to the old Sami culture, the newborn spent the beginning of his or her life in a cradle called “gietka” or komsio. In that the hips are forced into a maximal negative position with full adduction and extension and internal rotation. This position could be a possible reason for a predisposed dislocation, if not, the main reason for the development of this disease. The prevalence of this condition was 5% in Finnmark North Sami population (Wessel 1918). Getz (1955) found later that it was 4%. That might be about the same as among the North Sami in Finland. CDH is more common among women than men. The sex ratio is about 4–5:1.

The pathophysiology and natural history of the range of morphological and clinical disorders that constitute developmental dysplasia of the hip are poorly understood. It is probably polygenetic inherited. Numerous studies have shown hereditary links in up to 25% of cases (Getz 1955). In hip dislocation, the ball at the top of the thighbone (femoral head) does not sit securely in the socket (acetabulum)

of the hip joint. Surrounding ligaments may also be loose and stretched. The ball may be loose in the socket or completely outside of it. Rather early in life, the CDH causes arthrosis to the hip joint. (Johnsen et al 2009)

Musculoskeletal disorders

The prevalence of self-reported musculoskeletal symptoms was asked from male reindeer herders of Finland and Sweden. The prevalence of musculoskeletal symptoms, particularly in the lower back, knees, hands/wrists, was high among Sami reindeer herders. Musculoskeletal symptoms constitute a considerable health problem in modern reindeer husbandry (Näyhä et al 1991, Näyhä et al 1994, Sjölander et al 2008). Reindeer herding work demands a lot of strength and consists of troublesome postures in different stages driving with snowmobile and other terrain vehicles. In that work, muscles should be healthy. The cold is not good for muscles and abundant clothing sometimes makes moving clumsy. Back pain, neck and shoulder pains and joint symptoms increased with the amount the reindeer herding work done annually (Näyhä et al 1993).

2.5.6 SKIN DISEASES

When Sami skin diseases were studied from patient records from 1961 to 1978 in the Inari-Utsjoki Health Centre, among the North Sami (1093 persons, 20,765 person years (py)), Inari Sami (614, 11,667), Skolt Sami (448, 8,504) and non-Sami (4343. 82,523), and mixed group (680, 11,957), altogether 932 cases of skin disorders were found (Kirjarinta 1987). The age-adjusted incidence of all skin diseases was lowest among the Skolt Sami men 3.0 /1000 py and the non-Sami women had the highest 11.7/1000 py. The rest had incidences between 5.5 (Skolt Sami women) and 10.7 (Inari Sami women). In every ethnic subgroup, the women had higher incidences than men. Psoriasis was missing among the Skolt Sami group. The North Sami had the highest incidences 0.7 /1000 py (men) and 0.9 (women). Dermatitis (ICD 10: L20-L30) was more common among women than men in all groups. The Inari Sami had the highest incidence and the Skolt men the lowest, 5.4 /1000 py and 0.5 correspondingly. Dermatitis was most common among the Inari Sami (men 4.1 /1000 py, women 5.3). The corresponding numbers among other groups were North Sami 2.9 and 4.6, Skolt Sami 0.5 and 2.7 and non-Sami 3.0 and 4.5 /1000 person years. Among Inari Sami women, urticaria (ICD 10: L50-L54) was also common, when Inari Sami men and Skolt Sami women had no cases of urticaria.

Karvonen et al (1976) studied skin diseases of 75 North Sami and 110 Inari

Sami. 47 (25%) had at least one skin disease. Three psoriasis cases were found, 1 North Sami (1.3%) and 2 Inari Sami (1.8%). In that material, there were 7 cases of dermatitis among the Inari Sami and 1 case among the North Sami.

A total of 11 cases of psoriasis, 6 females and 5 males, were found among the approximately 2,000 Sami in Kautokeino (Kavli et al 1985). This gives an estimated prevalence of psoriasis of 0.6%.

2.5.7 DENTAL HEALTH

From the time of Linnaeus, it was known that the Sami have white, strong and healthy teeth. Caries was found only in 1.5 per cent of the total number of 9,700 examined teeth (Selmer-Olsen 1949). In 1938 the medical doctor of Ivalo was surprised at the healthy teeth of the Suenjel Skolt Sami, being accustomed to the very poor dental status of the Inari Sami and the Pasvik Skolts. Since that time the situation has changed totally when the Skolts started to eat more carbohydrates and sugar. The fare of the Suenjel Skolts had been based almost exclusively on meat and fish.

In 1967 and 1970 the oral conditions of the Skolt Sami were studied by Hansson (1976). Already in the age group 30 to 44, almost 35 per cent of the females and 16 per cent of males had lost their teeth. This continued in subsequent age groups. Total loss of teeth was most common among females at all ages. The age group 65 and over had grown up under more beneficial nutritional conditions (less sugar) than the younger Skolt Sami, and this may partly explain why fewer of the oldest age group were edentulous.

Hypodontia (missing of teeth motif) is frequent in small, isolated and inbred populations. 28/500 Skolt Sami had 1–4 missing teeth (Hansson 1976). Oral hygiene was also studied, and it was found that about 90 per cent of males over the age 16 had poor oral hygiene, and in the younger age groups, 70–80 per cent had poor oral hygiene. Females showed a somewhat better situation; only one-third of the youngest age groups had poor oral hygiene and in the age groups 16 to 19 and 20 to 29, about 50 per cent had fairly good oral hygiene.

Helkimo et al (1972) studied the function of occlusion of 256 Skolt Sami and 72 Inari Sami aged 15–65 years and found that almost 50% of the subjects examined had functional disorders of the masticatory apparatus. More than one third of those examined reported neck and shoulder pain and roughly every fifth often had a headache.

The extent of caries and the state of the teeth in the Skolt Sami above 20 years was very severe throughout (Lewin et al 1971). Extensive destruction and loss of teeth were very common. The dental treatment available consisted mainly of extraction.

The condition of the Inari Sami was somewhat better.

Equity required by the Primary Health Care Act was achieved in the availability of dental health care quite well among Finnish Sami children in 1973 – 1988 (Pitkänen 2000). Compared to Norwegian Sami children, the availability of dental care was almost the same among Finnish Sami children under the study period.

2.5.8 INFECTIOUS DISEASES

Tuberculosis

Tuberculosis has been a long-lasting pandemic that is not over yet. At the turn of the 18th and 19th centuries, tuberculosis was on the parallel of Vaasa in Finland going to the north (Sandblad 1979). Since the nineteenth century, Lapland has been one of the most unfavourable parts of Finland with respect to morbidity and mortality from tuberculosis (Palva et al 1976). In 1951 a tuberculosis hospital and an outpatient clinic was opened for Lapland. Since that time the tuberculosis incidence decreased from 403 new cases in 1953 to 86 new cases in 1970. Ebeling (1974) has compared the tuberculosis in Lapland and among Sami. In 1951–55 the incidence in Lapland was 4.00/1,000 person years (py) and among Sami 4.20/1,000/py. In 1966–1968 the corresponding figures were 1.89 and 2.56/ 1,000/py. The worst morbidity in 1951–1968 was among the Sami in Inari (majority are Inari Sami), the annual incidence, 3.52/1,000/py. The best situation was among the Sami in Utsjoki (North Sami) 1.84/1,000/py and Skolt Sami between the former, 2.84/1,000/py. Tuberculosis existed later in Lapland than in Finland and among Sami later than in Lapland.

The mortality from tuberculosis in 1921–30 among 15–60 year old people per 10,000 per year was in Inari hundred (jurisdictional district) 17 and in Utsjoki hundred 19. At the same time it was in the neighbour hundred Petsamo 54 and in Lapland 28. The low figures in Inari and Utsjoki may be attributed from fewer connections and in Petsamo on the contrary from many connections and diverse population. (Savonen 1937)

During 1960–1974 in the Inari-Utsjoki area, 13 people altogether died from tuberculosis (Statistics Finland 1960–1974). It is not known if they were Sami or non-Sami. The incidence of tuberculosis in Lapland in 2005–2009 was 9.5/100,000/person years. The corresponding figure of Finland during 2007–2011 was 7/100,000/py.

The provincial medical doctor Johan Ångström in Swedish Southern Lapland reported only a very few cases of tuberculosis in the year 1854, although it was already very common in Sweden at that time. The death diagnoses were often made by priests, and it is assumed that the differential diagnosis between tuberculosis

and other pulmonary diseases was not easy for a layman (Ångström 2012). In Finmark, Norway the Tuberculosis epidemic started in about 1870–1880, and it was worse than in Norway generally (Ryymän 2008, Wessel 1911/Forsdahl 2000). It was slowing down in about 1955.

During 1957 and 1958, the lungs of 450 Swedish Sami schoolchildren were checked by photofluorographic or an ordinary x-ray examination, and tuberculin tests were performed (Melbin 1962). No case of active disease, tuberculosis or other, was found. In 7%, minor hilus changes or calcifications were observed that indicated previous disease. The amount of tuberculin negative children was 39%.

The immune system of those people who have been living isolated for centuries have not developed antibodies for contagious diseases outside their community. That is the reason why infections they get after outside contacts can have a very deleterious impact. The tuberculosis pandemic has been a long-lasting and very harmful epidemic for many arctic peoples. The life expectancy in Greenland was less than 30 years during the worst tuberculosis epidemic, and in the beginning of the 1970s, when the epidemic and infectious diseases as a whole had slowed down, it was about 60 years (Harvald 1971).

Respiratory infections

In cold areas, respiratory infections caused by viruses and bacteria are common and to the sequels belong otitis, sinusitis, bronchitis and pneumonia. The viruses come first and prepare the circumstances suitable for the infection of bacteria. Otitis media is a universal medical problem, particularly among infants and young children. Examinations of the children's hearing (audiometry) in the nomadic Sami schools in Norrbotten showed a high incidence of hearing impairment, especially as a result of previous infections (Melbin 1962).

Chronic suppurative otitis media is common in all arctic populations (Lupin 1976). This is due to the high incidence of acute otitis media, particularly in infancy and childhood and its often unsatisfactory treatment. In a study from Tromsø, Norway, the outbreaks of upper respiratory infections in children during a 5-year period coincided with the periods of the greatest number of days with wind force above or equal to a strong breeze. In Longyearby in Spitsbergen, it was found that otitis media was apparently related to seasonal shifts in temperature (Andersen et al 1997). On the other hand, viruses and the bacteria are always needed before the infection.

There is no evidence that ear disease was widespread among Canadian native peoples prior to contact with Europeans (Baxter 1991). The early explorers of the Arctic described the Inuit as being strong, healthy people. Except for occasional

contacts with whalers and fur traders over the years, the majority of the native people lived there in relative isolation until after the last World War. After that, tremendous social changes occurred among the native peoples.

Respiratory symptoms and ventilator function was studied among Finnish reindeer herders. The prevalence of chronic bronchitis was 10% in non-smokers and 28% among regular smokers, while the prevalence of cough was 18% and 23%, and that of phlegm 10% and 34% respectively. 14% had dyspnoea caused by cold air inhalation. These were 211 randomly chosen male reindeer herders, aged from 21 to 69 (mean 45 years). It is not known how many of them were Sami (Reijula et al 1990).

From the 1960s there are reports of Canadian Inuits with extensive impairment of pulmonary function (Beaudry 1968, Schaefer 1980). Hildes et al (1976) examined the chest radiographs of 315 adults in the beginning of the 1970s in connection of the Canadian IBP projects, and pulmonary function tests of 161 persons were analyzed. It was found that more than a quarter of the adults over 50 years of age had severe changes of chronic obstructive pulmonary disease (COPD) as judged from the chest radiographs, but the young men and women aged 20–29 were reported as mostly normal. They also found from the ventilation function tests that the maximum mid-expiratory flow rates were much below those predicted, and the electrocardiogram showed a preponderance of changes arising from the right side of the heart (which means problems in the lungs). It is not known what cold air and strenuous exercise has done among the Sami in past times.

Influenza and other epidemics

The influenza pandemic, a Spanish disease in 1920, killed a tenth of the Inari population in two months. At that time (1911–1920) the crude death rate in Inari was 28.2/1000 (Table 1). The Spanish disease was a bad setback for the Inari Sami people. Among other things, there were several orphaned children after the epidemic who were raised in a children's home away from the Sami culture (Linnanmäki 2005). The former isolation of several arctic populations caused high mortality from influenza because of the "virgin soil" phenomenon. When immunity of a whole population is missing, the impacts of diseases are very destructive. That was the case in Inari. In the Sami municipality of Arjeplog in Sweden, 3% of the population died in February 1920. It was the same in Norwegian Sami municipalities, and in Alaska from October 1918 to February 1919, 8% of the indigenous peoples died. In 1910, the Sami population in Inari was 999 and at the end of 1920, only 806. At the same time, the tuberculosis epidemic was going on, and in Inari there had been an epidemic of scarlet fever in 1919 (Lehtola 1998). The Sami were afraid of

smallpox (Itkonen 1948). They knew that there was no medicine for smallpox. In the early 19th century 10% of the population in Enontekiö came down with smallpox. At that time, the Enontekiö municipality was Sami, and they were nomads. The measles epidemic was in Inari in 1855. Varicella was also known among the Sami.

Echinococcosis

Echinococcosis or hydatid disease has been earlier an endemic parasite in the reindeer herding areas in the Nordic countries (Rein 1957). The definitive host is the dog (today wolf) and the intermediate host is reindeer or elk (Hirvelä-Koski 2003). If the Sami got the eggs, usually from the dog, the result was a hydatid cyst or several of them in the lungs or liver. The hydatid disease has disappeared with hygiene education, but still in 1970 advice was needed in Northern Lapland and Norway (Lääkintöhallitus 1970).

There is not any information about endemic infections like hepatitis among Alaskan natives and Greenland Inuits (McMahon 2003).

2.5.9 OTHER DISEASES

The Sami appear to have a low frequency of myopia and color sense disturbances, and they have extremely low intraocular pressure (Forsius et al. 1971, Forsius 1980). The Sami knew also “some pearl” in the eyes, which came in the bright spring. That may have been an eye cataract (Itkonen 1948). Also obesitas, appendicitis, cholecystopathy, varicose veins, and hernias seem to have lower frequencies among the Sami than among the general Finnish population (Eriksson 1988).

Children had rickets (Itkonen 1948, Melbin 1962, Eriksson 1988). That was very common among all Sami children. The Sami children did not get enough sunlight during the short summer. There were still some cases of rickets among Finnish Sami in the 1960s (Louekari 1967). The lack of vitamin D in connection with UV radiation has been discussed earlier (in chapter 2.2.2).

The symptoms caused by driving a snowmobile can be regarded as occupational diseases of the reindeer herding Sami. The driving causes a lot of symptoms in addition to accidents. Typical symptoms are in the limbs and back (Näyhä et al 1994). Vibration in connection with smoking and coldness cause the white finger syndrome, which predisposes to frostbite (Virokannas et al 1994). Hearing loss is often the result of driving snowmobile without protecting the ears (Anttonen et al 1994).

2.5.10 MORTALITY STUDIES AMONG SAMI

Itkonen (1948) has analysed the causes of death of 666 people from the parish registers in Inari 1750–1814 and 1838–1860 and in Utsjoki 1749–1813. The main cause of death was “weakness of old age” 24%, some kind of pain (pistokset) 13%, different infections (smallpox, scarlet fever, pertussis, puerperal fever, measles, dysentery etc) 22%. Of the deaths 8% were accidents: drowning, getting lost, frostbite and other accidents. There were 3 cancer deaths and 3 heart disease deaths. The diagnoses are rather uncertain, but a little directional. Accidents and epidemic deaths may have been rather correct.

Since 1840, the crude death rate of the Sami in Inari has been lower than that of Finland. In 1840 the mortality in Inari was 9.9/1000, (in Finland 21.9), in 1850 17.3 (26.2), in 1860 10.0 (24.6), 1870 13.9 (18.0) (von Bonsdorff 1971, Statistics Finland 2014). One exception has been in the years 1911 - 1920, when there was World War I and in 1920 the Spanish disease (Linnanmäki 2005). At that time, the crude death rate in Inari was 28.2 (Table 1). Mortality among the Skolt Sami greatly increased during the war years 1939–1944 (Figure 6). The decrease in death rates after 1950 depends on better living conditions. It was believed that tuberculosis has been responsible for the high mortality rates of Skolt Sami in periods 1935–39 (Nickul 1943). The Skolt children from Suenjel may have had a higher susceptibility to grave infectious diseases than the Skolts, who came from Petsamo, where they had begun integration with Finns already in 1920s (Lewin et al 1971).

The crude death rate in Inari has been found to be lower than that of the corresponding rate in the whole country in 1961–1987 (Näyhä 1987). In 1961–1990, the disease mortality rate of the Sami municipalities was also low (Näyhä 1997). The standardised mortality ratio (SMR) of Utsjoki males was 0.68 (95% confidence interval 0.58–0.81) and females 0.84 (0.69–1.02). In Inari, the corresponding figures were 0.93 (0.87–1.00) and 0.96 (0.87–1.05).

From 1990, the Social Insurance Institution has calculated indices of mortality for every municipality. The percentage of the Sami in Inari has been about 30 since 1940 and in Utsjoki at least 70, but since 2003 about 60 (Appendix 1). The indice is adjusted by age- and gender. The indice for whole country is 100. The adjusted indice of mortality in Lapland has been about the Finnish average, but that of Utsjoki has been low until the year 2000 and thereafter about 2006 back under the national indice. The mortality indice of the Inari municipality has been mostly higher than the national average, but in 2007 it has turned lower (Figure 24).

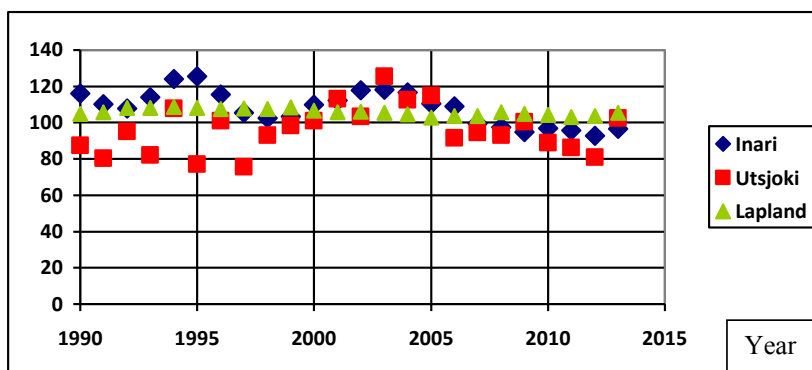


Figure 24. The mortality index¹⁾ of Inari and Utsjoki municipalities and Lapland in 1990–2013.

¹⁾The mortality index is the ratio of the percentage of deaths in the population of the municipality and percentage of deaths in the whole country multiplied with 100. The percentage of the municipality is the sum of all deaths during 3 years dealt with the mean of population during the same 3 years. The index for whole country is 100. (Kela mortality index NTO79A). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1). http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NIT079AL&YKIELI=E

Mortality of Sami in Sweden and Norway

Wiklund et al in 1991 published the first work concerning the mortality pattern of about 2000 reindeer breeding Sami in Sweden. Until that time the studies concerned the whole population of the Sami municipalities (Näyhä 1987). Also, it was known from the statistics of Statistics Finland and the statistics of the Cancer Registry that some diseases were low (cardiovascular diseases, cancer) in Sami municipalities and some causes of death were more common like accidental deaths. In the study of Wiklund et al (1991), it was found that mortality from diseases of digestive system and cancer were significantly decreased when compared to the mortality of general population. The ischemic heart disease and cerebrovascular diseases were not decreased.

In the Swedish Sami study (Hassler et al 2005), 41,721 Sami, 34,239 non-reindeer herding Sami and 7482 reindeer herding Sami were compared with 144,930 corresponding demographically matched non-Sami reference population. The overall standardized incidence ratio (SMR) for Sami men was similar to that for men of the reference population, while a slightly higher overall SMR was observed for Sami women. The cancer mortality rates of men in both Sami groups were significantly lower than that of the men of the reference group. The SMR of the subarachnoid hemorrhagia was increased among both Sami groups. A significantly lower SMR was observed on diseases of the digestive system among reindeer herding Sami men, whereas their SMR for external causes of injuries suicides and vehicle accidents were increased.

When the mortality of 19,800 Norwegian Sami was studied (Tynes et al 2007), it was found that in total mortality there was not difference between Sami and their

reference population (SMR 1.08), but cerebrovascular diseases were increased in both Sami men and women. The mortality from all malignant diseases was decreased among both genders when compared to the three Norwegian counties included in the study. To be a member of a reindeer breeding household appeared to offer protection from mortality caused by circulatory system diseases in men, especially mortality from ischemic heart disease.

Common to these 3 studies are the factors that the mortality from all causes of deaths does not differ from the total population, cancer mortality is decreased and accidental and violent mortality is increased.

Infant mortality

Infant mortality is a good indicator of health care, the common health situation, living standard, environmental circumstances and the education level of the population.

Wallquist (1945) has described the circumstances among the Swedish Sami in the 1930s from the point of view of the medical doctor when the population was sparse and distances long without roads. The start of an infant Sami life was not easy, and infant mortality was high. Among Russian Sami, infant mortality was 40% (400 per 1000 live births), among Skolt Sami 33% (Tanner 1929), among Norwegian Sami 25% (Rein 1956). among Swedish Sami in Norrbotten 7.6% (Melbin 1962) Infant mortality among Skolt Sami during the time from 1925 to 1964 is seen in table 6 (Lewin et al 1971).

The crude infant death rate was in Inari 1911–1920 141.6/1000 live births, 1921–1930 120.0, 1931–1940 105.9 in 1961–70 21.4 (von Bonsdorff et al 1974). In 1970–79 the infant mortality in the Sami municipalities Inari, Utsjoki, Enontekiö was 13.7 (in Finland 10.3) (Soininen et al 1982). v Bonsdorff found that the Finnish genes among the parents of a child had an infant mortality increasing effect. The more there were Sami genes among parents, the lower was infant mortality in 1840–1869.

Table 6. Number of births, number of the infant deaths and crude infant death rate during the period 1925–1964 in Skolt Sami families (Lewin et al 1971)

Five year period	No of births	Number of deaths of 0-1 years of age	1/1000 live births
1925-1929	35	0	0
1930-1934	54	3	56
1935-1939	57	11	193
1940-1944	52	8	154
1945-1949	64	8	125
1950-1954	81	8	99
1955-1959	65	4	66
1960-1964	48	2	42

Infant mortality in Greenland in 2012 was 9.8 /1000 live births (Index mundi 2012). In Nunavut (Inuits) 15/ 1000 and in Canada 5 / 1000 live births (Statistics Canada 2013). The corresponding figure in 2012 in Nordic countries is about 3–4 (Index mundi 2012).

3 THE AIM OF THE STUDY

There were reasons to assume that mortality and cancer patterns among the Sami differ from those among the non-Sami and could also vary between different Sami groups because of their varying degree of isolation in the past and the well-known genetic differences between them (Eriksson 1988). Also, the living environment of the Sami has changed, mainly due to increased radioactivity and chemical pollution, which could have affected the disease panorama among the Sami. The possibilities to study the Sami groups are diminishing all the time, because they are mixing with the main population at an accelerating speed. The mortality and cancer incidence among the Finnish Sami and their subgroups have not been previously studied.

The specific study questions were:

- (1) Do the total and cause specific mortality among the Sami differ from those among the non-Sami in same area and that among the general population of Finland? Are there differences in the cause specific mortality between the North Sami, Inari Sami and Skolt Sami?
- (2) Does the cancer incidence among the Sami differ from that among the non-Sami population in same area and that among the general population of Finland? Are there differences in cancer incidence between the North Sami, Inari Sami and Skolt Sami?
- (3) Are the mortality and incidence of cancer among the Finnish Sami similar to those among the Sami in Sweden and Norway?
- (4) Is the survival of the Sami cancer patients worse than the survival of cancer patients in all Finland?

4 MATERIAL AND METHODS

4.1 THE DESCRIPTION OF THE COHORT

The study cohort is based on the population living in the two northernmost municipalities of Finland (Inari and Utsjoki) on 31st December 1978, extracted from the National Population Register. Among this population, the Sami were identified by several methods. The starting point was the database created of Inari in 1966–1970 in conjunction with the World Health Organization International Biological Program (IBP)/Human Adaptability (HA), in which a number of interdisciplinary researchers studied the genetic adaptation of indigenous populations to the extreme Arctic conditions. All known Sami in Inari were identified based on their language and the language of their ancestors, their genealogy being abstracted from parish records (Nickul 1968, von Bonsdorff et al. 1974, Eriksson 1975, Milan 1980). The number of persons studied at this phase was 2498. The Sami were also picked up manually from the National Population Register, and their personal details were compared with the IBP/HA information. Based on those data, most cohort members could be assigned to subgroups of Sami (North Sami, also called Mountain Sami; Inari Sami, also called Fisher Sami; Skolt Sami). The original IBP/HA file is kept in Sami Archives of the National Archives in Finland.

During the period 1974–1978, persons not included in the original IBP/HA records were identified among the Inari and Utsjoki population based on their name (the Sami names differ from the Finnish names (Itkonen 1948, Steen 1952, Nickul 1968)), birthplace and asking the persons themselves or the local public health nurses. The additional Sami added to the cohort at this phase were mostly Northern Sami from Utsjoki municipality and Sami born after 1970. The final study population was computerized at the Department of Public Health Science of the University of Helsinki where also the personal identifiers were checked and corrected, this checking being repeated in the Finnish Cancer registry. The final Sami cohort comprised 2651 persons, i.e., about 82% of Finnish Sami in 1978 (Figure 25).

All residents of Finland since January 1st 1967 have a unique personal identifier that is used in all main population and personal health registers in Finland. Follow-up for cancer through the files of the nationwide Finnish Cancer Registry and national cause-of-death files was done using the personal identifier as the key.

The follow up started from 1st January 1979. Dates of death and emigration of the cohort members were obtained from the national population register. A person

representing at least 75 per cent of any ethnic group of Sami was classified as Sami. A non-Sami is a person without any Sami ethnicity, and the remaining persons were classified into the mixed group.

The Sami group (1) was dealt into subcategories, North Sami (1a), Inari Sami (1b) and Skolt Sami (1c) with the same principle, Sami persons had to represent at least 75 per cent of any single type of the three Sami subgroups. The sample of non-Sami (group 3) was chosen concurrently and consisted of those born on 1st to 24th day of any month and year, 4151 persons.

Table 7 shows the numbers of Sami and the person-years accumulated during the follow-up, separately for three age classes and three time periods. Figure 26 shows the age distributions of groups studied.

In studies I and II, the analyses are based on the Sami (75–100% of Sami ethnicity, group 1) and non-Sami group (group 3). In Studies III and IV, both Sami groups are combined (1–100% of Sami ethnicity, groups 1 and 2). In the mortality Study (I) and the cancer incidence Study (II), the Sami group is divided into Sami subgroups (1a, 1b, 1c, 1d) (Table 7).

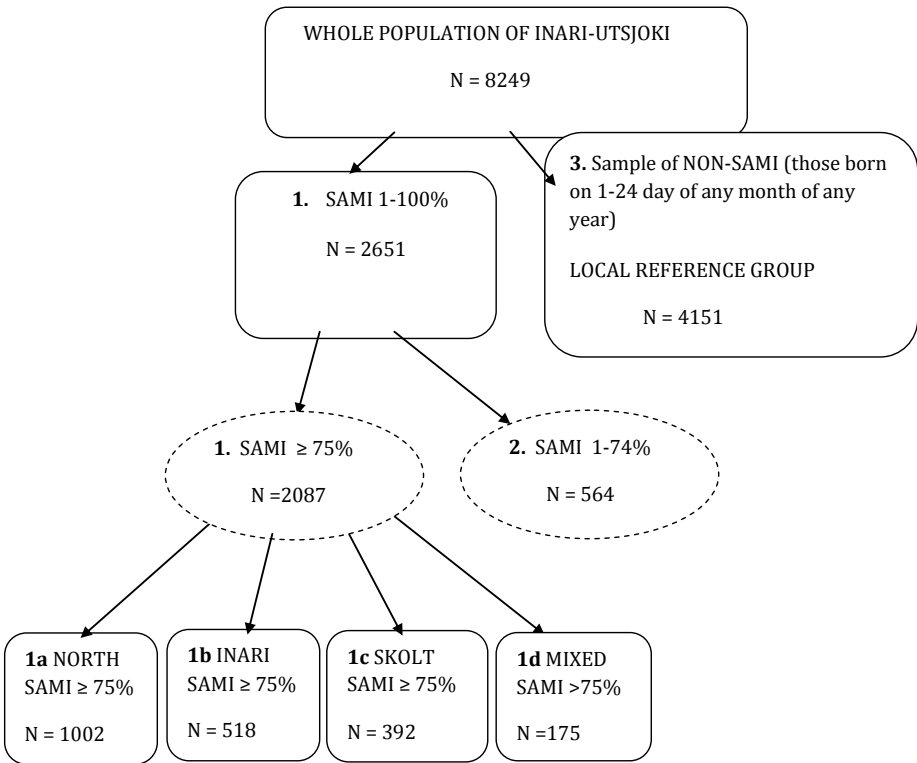


Figure 25. Numbers of persons (N) in the Sami and non-Sami cohorts in Inari and Utsjoki, 31 December 1978.

Table 7. Number of persons at follow-up, and number of person years at risk in 1979–1998, 1999–2010 and 1979–2010 by ethnic subcategory and age.

Genetic category age groups	Number of persons ¹	Person-years 1979-1998	Person-years 1999-2010	Person-years 1979-2010
1 Sami (75-100%)	2,087¹	36,646	16,952	53,598
< 30	978	11,151	769	11,920
30-59	723	17,020	10,573	27,593
≥ 60	386	8,481	5,610	14,073
1a North Sami	1,002¹	17,944	8,404	26,348
< 30	502	5,944	432	6,376
30-59	348	8,273	5,275	13,548
≥ 60	152	3,742	2,697	6,424
1b Inari Sami	518¹	8,816	3,809	12,626
< 30	181	2,002	196	2,198
30-59	194	3,989	1,964	5,885
≥ 60	143	2,897	1,649	4,543
1c Skolt Sami	392¹	6,641	3,088	9,729
< 30	184	1,832	56	1,888
30-59	136	3,474	2,096	5,473
≥ 60	72	1,432	0,936	2,368
1d Mixed Sami	175	3,245	1,651	4,895
< 30	111	2,372	85	1,458
30-59	45	1,384	1,238	2,687
≥ 60	19	410	328	738
2 Sami (1-74%)	564¹	13,951	7,370	21,321
< 30	425	8,673	803	8,073
30-59	114	5,438	5,411	10,850
≥ 60	25	4,517	1,157	2,399
3 non-Sami	4,151¹	76,664	39,431	116,095
< 30	2,262	28,805	3,114	31,919
30-59	1,515	36,737	2,545	62,169
≥ 60	374	11,123	10,886	22,008

¹ The numbers may differ in publications I-III because of additional checking of the data.

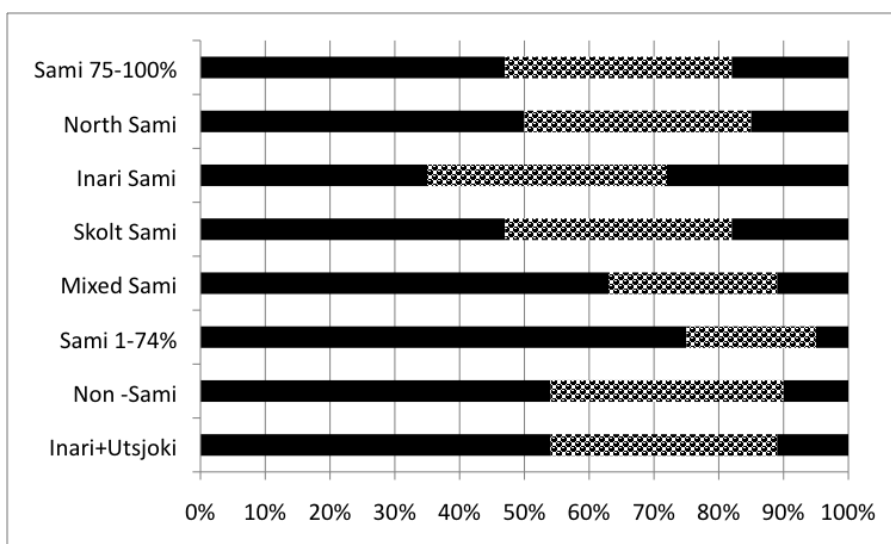


Figure 26. Age distribution of Sami and non-Sami groups and the population of Inari-Utsjoki in 31 December 1978. Men and women are combined. On the left (black): age <30 years, in the middle (gray): 30–60 years, on the right, (black): ≥ 60 years.

4.2 OUTCOME EVENTS

4.2.1 THE CAUSES OF DEATH (STUDY I)

The outcome events were the cases of death of the Sami and non-Sami cohorts. Statistics Finland produces statistics on causes of death and on the development of mortality. The statistics on causes of death are compiled from data obtained from death certificates that are supplemented with data from the population information system of the Population Register Centre. The statistics on causes of death cover the persons who have died in Finland or abroad during the calendar year and who at the time of death were domiciled in Finland (Statistics Finland 2010).

International Classification of Diseases of World Health Organization (WHO), ICD 8 was used in Finland in 1969–1986. In 1987–1995, the Finnish classification of diseases 1987 was used, which was based mostly on ICD 9 of WHO. From 1996 there have been 3 Finnish revisions based of ICD 10. Starting from 1969, mortality data are available as a combined longitudinal file on causes of deaths, and coded to form 53 longitudinal cause-of-death categories based on revisions of ICD-8, ICD-9 and ICD-10 (Statistics Finland 2005). Statistics Finland produces routine mortality rates for all these categories.

The underlying cause of death (UCD), direct cause, intervening causes and

contributing causes have been included to the causes of death in the death certificates. They have been in the register of Statistics Finland since 1987. Annual causes of death statistics are compiled according to the statistical UCD. The UCD is the disease that initiated the series of illnesses leading directly to death, or the circumstances connected with an accident or an act of violence that caused the injury or poisoning leading to death. The UCD used in statistics (statistical UCD) is determined according to the selection and application rules of the International Classification of Diseases (ICD-10) compiled by the World Health Organisation (WHO). (Statistics Finland 2010)

4.2.2 CANCER INCIDENCE (STUDY II)

The outcome events were the cancer cases among the Sami and non-Sami cohorts. The Finnish Cancer Registry maintains a nationwide database on all cancer cases in Finland going back to 1953. All physicians, hospitals and other relevant institutions in the country must send a report to the Finnish Cancer Registry of all cancer cases that come to their attention. Some pathological, cytological and haematological laboratories still send the respective report filled in manually, but the majority of laboratory notifications are currently automatically extracted from laboratory data systems, using a standard format set by the Finnish Cancer Registry. In addition, Statistics Finland sends information of all death certificates where cancer is mentioned. The cancer notifications submitted to the Finnish Cancer Registry are immediately stored in a database that contains data on virtually all cancers diagnosed in Finland since 1953. This database was used for these studies. The Registry has followed a slightly modified version of the ICD-7 nomenclature from 1955 for coding the primary site of cancer. However, during 2005 the Finnish Cancer Registry has gone over to the ICD-O-3.

In cancer Study II, 41 different cancers were surveyed of the Sami and non-Sami. Only 10 different cancer categories were surveyed among Sami subgroups. In the updated computer run, 63 different cancer categories were examined for all groups (Oct 17th 2012).

4.2.3 CANCER AMONG THE SAMI – A REVIEW ON THE NORWEGIAN, SWEDISH AND FINNISH SAMI POPULATIONS (STUDY III)

The outcome events were the death- and cancer cases of the Sami cohorts in Finland, Sweden and Norway. The outcome events were picked up by the same way from the death- and cancer registers in each country.

All publications until 2008 concerning Sami mortality and cancer morbidity were retrieved from MEDLINE and analysed and compared with each other. The Finnish number of cancers were updated for that study until Dec 31st 2006, and for the calculation of incidence figures the age grouping was narrowed, and all Sami, irrespective of their Sami-ness (1–100%), were included (groups 1 and 2). The non-Sami were not included in this comparative study. The Finnish reference population was the population of northern Finland (Hospital district of Lapland).

4.2.4 SURVIVAL OF SAMI CANCER PATIENTS (STUDY IV)

The outcome events were the deaths from the cancer and all causes among the Sami and non-Sami cancer patients.

The cohort consisted of 2,091 Sami and 4,161 non-Sami people. The survival experiences of the Sami and non-Sami cancer patients were followed up from Jan 1st 1979 to Dec 31st 2009. They were compared with the patients not belonging to the cohort, all cancer patients in Finland, excluding the Sami.

4.3 FOLLOW UP AND STATISTICAL METHODS

4.3.1 THE COHORT STUDY METHOD (STUDIES I, II, III)

Follow-up for cancer through the files of the population-based countrywide Finnish Cancer Registry and the national cause-of-death files using a personal identifier as the key was done. The first period of the follow-up for cancer started on Jan 1st 1979 and ended at death or on the common closing date, whichever was first. The starting year 1979 was determined by the possibility to get the population register of Inari and Utsjoki (1978). The closing years were as follows: study I: Dec 31st 2005, II: Dec 31st 1998, III: Dec 31st 2006. For this summary part of the thesis, the follow-up for both incidence and mortality were updated until Dec 31st 2010.

The methods of the standardized mortality ratio (SMR) and standardized incidence ratio (SIR) were the same. The numbers of observed deaths or incident cancer cases and person-years at risk were counted, by sex, age, 5-year age group, and for 5 or 6 year calendar periods. The expected numbers of cases for deaths or cancers were calculated by multiplying the number of person-years in each stratum by the corresponding average mortality rate or cancer incidence in the reference population (I-II: whole Finland, III: the health care district of Lapland). The 95% confidence intervals (CI) were defined on the presumption that the number of observed cases followed a Poisson distribution. In addition, the ratios of the standardized incidence ratios of subpopulations were calculated with their 95% CIs.

Study I included all cause-of-death categories from a short list of longitudinal mortality classification of Statistics Finland (Statistics Finland 2005). The longest comparable time series classification (54 categories) is from 1969 onwards. Statistics following this classification are available in Statistics Finland's database under the topic "Health".

The Finnish Cancer Registry compares the official causes of death of each cancer patient (transferred from Statistics Finland through an automatic record linkage procedure) to all data available for that cancer, and evaluates whether the patient died from that cancer or something else. The cancer mortality rates refined by the Cancer Registry allow the use of more detailed classifications of the cancer itself than the official ones produced by Statistics Finland. Since the 1980s, the official mortality rates have been very close to the refined ones (Finnish Cancer Registry 2014).

The specific cancer types selected a priori for the analysis in studies II-III included those with a known or suspected exceptional risk, all those cancers which might have abnormal, low or elevated incidence in earlier studies or which were known to be caused by radioactivity and all common cancer types to give a global picture of the cancer situation among the Finnish Sami population.

4.3.2 THE COMPARISON OF SAMI CANCER IN FINLAND, SWEDEN AND NORWAY (STUDY III).

A systematic search over the time period from Jan 1st 1966 to March 31st 2008 was conducted on MEDLINE to find all studies concerning Sami cancer incidence and mortality. Nine studies were found and as well as authors of those studies from every country - Sweden, Finland and Norway. It made recalculations possible from the basic data for comparison. The cohorts were constructed by different ways in different studies.

The numbers of the Sami in various cohorts ranged from 2034 to 41,721. The first study was published in Sweden by Wiklund et al (1990). In that study, the Sami population consisted of 2034 reindeer herders and their family members, which were found from 1960 Population and Housing Census. It means that the cohort contained only those Sami who were involved in reindeer breeding. Reindeer breeding is an exclusive right for Sami people in Sweden. Hence, all reindeer herders are Sami. That cohort was followed until 1985. The same material was used by Wiklund et al (1991) to study mortality (Study III, Table 1).

The same cohort from 1960 was used by Hassler et al (2001), but added the follow up time until 1997. A corresponding cohort from the year 1980 of 1988 reindeer herders was also followed until 1997.

The reindeer herder cohort was later expanded to non-reindeer-herding Sami and reconstructed the entire Swedish Sami population by identifying relatives of reindeer-herding Sami and voters in the elections for the Sami parliament. The relatives were traced through the kinship registers of the Swedish National Bureau of Statistics (41,721). The reference population was a population of demographically matched (gender, age and area of residency corresponding 1960 and 1980) non-Sami population, four times as large as the Sami (144,930). Different sub-cohorts were then followed up with respect to cancer incidence and mortality over different time periods between 1961–1997 and 1961–2003 for the cancer incidence, and 1961–2000 for the mortality. (Hassler et al 2005, Hassler et al 2008).

The Norwegian studies were based on a cohort of 19,801 Sami identified through a survey of Sami ancestry that was performed in the census of 1970 in the 3 northernmost counties of Norway: Nordland, Troms and Finnmark (Haldorsen et al 2005, Tynes et al 2007). In this census, questions on the use of the Sami languages and Sami self-identification were used to estimate the degree of Sami ancestry. The questions were:

- Was Lappish (Sami language) the first language spoken by the person?
- Was Lappish the first language spoken by one of the person`s parents?
- Was Lappish the first language spoken by one of the person`s grandparents?
- Does the person consider himself or herself to be a Sami?

Moreover, based on the area of residency and the occupation, the Sami cohort was divided into 4 subpopulations: living in areas with no reindeer breeding, some reindeer breeding, or the core area of reindeer breeding, and being a member of a reindeer breeding family. The cancer incidence was analysed for the period 1970–1997 and the mortality was analysed for the period 1970–1998 using two reference populations: the Norwegian general population and the rural population of the 3 northernmost counties. Comparison of standardized incidence ratios for 6 cancer sites and all sites was done.

For Study III, the Finnish results from Study II were updated until Dec 31st 2006 and the SIRs calculated by using the population of the Hospital district of Lapland as reference. The Sami groups with 75–100% and 1–74% Sami genome (groups 1 and 2 in Table 13) were combined to harmonize the Finnish Sami population with those of the other countries.

To make a comparative incidence follow-up during the period from 1970 to 2006, some raw results were recalculated. Incidences were calculated for five time periods per 100,000 person years and age adjusted with world standard population. Those incidences were compared graphically as a function of time to each other and to incidences of general population. The follow- up starts and ends in different times in different studies.

4.3.3 THE CANCER SPECIFIC SURVIVAL (PAPER IV)

For the survival Study (IV), all Sami and non-Sami cancer cases (representative of the general population of the same area) were identified from the Finnish Cancer Registry. Emigrated cases and their emigration dates were identified from National Population Register and those who moved during the monitoring time were censored. The deaths were obtained from the mortality register of Statistics Finland. All this data was linked by the personal identification code and it was updated to Dec 31st 2009.

To produce comparative cancer-specific survival figures, the Sami cancer patients and non-Sami cancer patients were matched to other Finnish cancer patients obtained from the Finnish Cancer Registry with respect to site, gender, age at diagnosis and year of diagnosis, and in a separate analysis also with respect to the stage. The stage was analysed in five categories: (a) localized, (b) regional, (c) distant, (d) non-localized, not known whether regional or distant, and (e) unknown. All available controls were accepted into the analyses. A similar matching was also made for non-Sami cancer patients.

Cancer-specific survival analyses were conducted using the matched Cox regression model (1972) only for all-site cancers because of the small number of cases. Weighted survival analyses were made separately for Sami and non-Sami cancer patients using the Kaplan-Meier method. The weight for each matched control was calculated as the inverse of the number of controls for each case (i.e. $\text{weight} = 1 / \text{number of controls for each case}$). The statistical software, STATA (Release 12), was used to calculate 5-year cumulative weighted cause-specific survival figures. In addition to the cancer-specific analyses, regular matched overall or all-cause survival analyses were also performed, disregarding the cause of death information.

Cancer-specific survival analysis was employed, i.e. the outcome is a net survival measure representing survival from a specified cause of death, in this case the patient's cancer, in the absence of other causes of death. The survival times of individuals who died from causes other than those specified and those who emigrated are considered to be censored.

The cancer-specific survival experience of patients classified as Sami and non-Sami was compared with that of the Finns outside the cohort. The 5-year cancer-specific survival was estimated only for all cancers combined because of the small numbers of individual cancers. To produce comparative analyses, regular matched overall or all-cause survival analyses were also performed, disregarding the cause of death information.

4.3.4 UPDATE OF RESULTS OF PAPERS I-II

The statistics of the mortality and cancer incidence studies have been updated until Dec 31st 2010 to see if some changes have occurred among Sami (and non-Sami). For the mortality study there are 5 years more (from Jan 1st 2006 to Dec 31st 2010) and for the cancer incidence study 11 years more (from Jan 1st 1999 to Dec 31st 2010).

4.4 PERMISSIONS

The following permissions were obtained for this study:

Terveyden ja hyvinvoinnin laitos (THL) Decision 18th April 2012, Dno

THL/1684/5.05.00/2011

Kela 8.3.2012 , Kela 9/522/2012

Ministry of Social Affairs and Health. Decision 14th April 1992

National Board of Health . Decision 16th August 1990

Statistics Finland 16th October 1978

Ethical Committee of Pohjois-Pohjanmaan sairaanhoitopiirin kuntayhtymä,

Statement 30/2011

5 THE RESULTS

5.1 MORTALITY (I)

The observed number of deaths among the Sami was 626 and among the non-Sami, 842 in 1997–2005. In addition, there were 107 deaths among Sami and 146 deaths among non-Sami in 2006–2010. The total mortality of Sami in 1979–2010 was the same as the national average, but in 1979–1987, the SMR of Sami was marginally below it (Table 8). The total mortality of mixed Sami (1–74 Sami ethnicity) was about the same as that of the general population. The total mortality of non-Sami was slightly higher than the national average. Their relative mortality did not change from 1979 to 2010 (Table 9).

Table 8. The mortality of the Sami groups 75–100%, (group 1) and 1–74% Sami ethnicity (group 2) and non-Sami, (group 3) during three 9-years periods and one 5-years period. Observed (Obs) number of deaths, standardized mortality ratios (SMR) and 95% confident intervals (CI). The standard population is the population of Finland (1.00).

	75-100% Sami (Group 1)			1-74% Sami (Group 2)			Non-Sami (Group 3)		
Time period	Obs	SMR	95% CI	Obs	SMR	95% CI	Obs	SMR	95% CI
1979-1987	191	0.86	0.75-0.99	12	0.71	0.37-1.23	254	1.09	0.96-1.23
1988-1996	232	1.03	0.90-1.16	25	1.07	0.69-1.58	281	1.04	0.92-1.16
1997-2005 ²	203	1.02	0.89-1.16	30	1.26	0.85-1.79	307	1.05	0.93-1.16
2006-2010 ¹⁾	107	1.08	0.89-1.29	14	0.84	0.46-1.41	146	0.89	0.75-1.04
Total	733	0.99	0.92-1.05	81	1.00	0.80-1.24	988	1.03	0.97-1.09

¹ New results for the updated period. ² The numbers are slightly different from published numbers because of additional checking of the data.

The SMR for total mortality of North Sami and Inari Sami was close to 1, but that of the Skolt Sami was significantly elevated, SMR 1.23 (95% CI 1.04–1.44). The three leading causes of death among the Sami men were the circulatory diseases (44%), cancer (15%) and accidents (10%) and among the Sami women, the circulatory diseases (43%), cancer (19%) and dementia and Alzheimer disease (12%). The order of the causes of the non-Sami was the same.

Table 9. Observed (Obs) number of deaths and standardized mortality ratios (SMR) with 95% confidence intervals (CI) among the Sami and non-Sami cohort **males and females** combined in 1979–2005 (I) and 2006–2010 (new results) and total (1979–2010) accident and disease mortality. The standard population is the population of Finland (1.00).

Cause of death	Time period	Sami			Non-Sami		
		Obs	SMR	95% CI	Obs	SMR	95% CI
Accidents	1979-2005	47	1.69	1.24-2.24	72	1.63	1.28-2.05
	2006-2010 ¹	7	1.52	0.61-3.13	6	0.70	0.26-1.53
	1979-2010	54	1.64	1.23-2.14	78	1.46	1.16-1.82
Diseases	1979-2005	544	0.93	0.86-1.01	733	1.05	0.98-1.12
	2006-2010 ¹	95	1.03	0.83-1.26	138	0.92	0.77-1.07
	1979-2010	640	0.93	0.86-1.00	871	1.01	0.94-1.07
Cancer	1979-2005	101	0.79	0.65-0.95	184	1.06	0.91-1.22
	2006-2010 ¹	26	1.18	0.77-1.72	34	0.83	0.58-1.16
	1979-2010	127	0.83	0.70-0.98	218	1.00	0.87-1.13
Non-cancer diseases	1979-2005	443	0.97	0.88-1.06	549	1.05	0.96-1.14
	2006-2010 ¹	69	0.99	0.77-1.25	104	0.95	0.78-1.16
	1979-2010	513	0.97	0.89-1.06	653	0.99	0.92-1.07

¹ New results for the updated period.

The SMR for accident mortality was significantly increased among Sami and non-Sami, compared with the national mortality. Among both groups, it has slightly decreased and the cancer mortality of Sami has increased during the last 5-year period. The non-cancer disease mortality has stayed close to 1 (Table 9).

5.1.1 DISEASE MORTALITY (NATURAL MORTALITY)

The SMR for natural mortality among Sami men was significantly decreased (Table 10), while that among Sami women was not (Table 11). The disease mortality of the North Sami and Inari Sami was significantly lower and that of the Skolt Sami was significantly higher than that of the general population (Table 12).

Significantly lower SMRs among male Sami were found for all diseases, malignant diseases, diabetes and other circulatory diseases, while no elevated SMRs were found in any other disease category. Significantly elevated SMRs among non-Sami men were found for total mortality and mortality from malignant diseases.

Among Sami women the SMR for ischaemic heart disease (IHD) was significantly decreased and that for other heart diseases (OHD) significantly elevated.

Table 10. Observed (Obs) numbers of deaths and standardized mortality ratios (SMR) with 95% confidence intervals (CI) among **male** Sami with 75–100% of Sami ethnicity and among the non-Sami cohort members in 1979–2010. The standard population is the population Finland (1.00).

Cause of death ICD-10	Sami men			Non Sami men		
	Obs	SMR	95%CI	Obs	SMR	95%CI
All causes 01-53, A00-R999	412	0.96	0.87-1.04	614	1.08	1.00-1.16
All diseases 01-41, A00-R99, X45	338	0.86	0.77-0.95	517	1.04	0.95-1.13
Infectious and parasitic diseases A00-B99, J65	2	0.63	0.08-2.29	5	1.23	0.40-2.86
Tuberculosis A15-A19, B90, J65	2	1.58	0.19-5.71	3	1.99	0.41-5.81
Malignant neoplasms C00-C97	62	0.68	0.52-0.87	151	1.20	1.02-1.40
Endocrine, nutritional and metabolic diseases E00-E99	0			10	1.62	0.78-2.97
Diabetes mellitus E10-E14	0			10	5.31	0.90-3.46
Dementia and Alzheimers disease F01, F03, G30, R54	22	1.42	0.89-2.14	22	1.49	0.94-2.26
Other diseases of the nervous system and sense organs G00-G29, G31.0-G31.1, G31.8-G62.0, G62.2-G72.0, G72.2-H95	5	0.83	0.27-1.93	5	0.83	0.27-1.93
Diseases of the circulatory system I00-I42.5, I42.7-I99	183	0.92	0.79-1.05	249	1.02	0.90-1.14
Ischaemic heart diseases (IHD) I20-I25	110	0.87	0.71-1.03	178	1.10	0.96-1.27
Other heart diseases excl. rheumatic heart diseases (OHD) I30-I42.5, I42.7-I52	22	1.28	0.80-1.93	13	0.66	0.35-1.12
Cerebrovascular diseases I60-I69	44	1.14	0.83-1.52	46	1.04	0.76-1.39
Other circulatory diseases I00-I15, I26-I28, I70-I99	7	0.42	0.17-0.86	12	0.62	0.32-1.08
Diseases of the respiratory system J00-J64, J66-J99	35	1.56	0.87-2.57	37	0.94	0.66-1.29
Pneumonia J12-J18, J84.9	12	0.63	0.32-1.09	11	0.62	0.31-1.11
Bronchitis and emphysema J40-J44, J47	19	1.28	0.77-1.99	9	1.70	0.78-3.22
Asthma J45-J46	2	2.93	0.35-10.59	0		
Diseases of the digestive system K00-29.1, K29.3-K67, K71-K85, K86.1-K93	7	0.74	0.30-1.51	11	0.95	0.47-1.70
Diseases of the genitourinary system N00-N99	6	1.49	0.55-3.25	2	0.53	0.06-1.91
Alcohol related diseases and accidental poisoning by alcohol F10, 31.2, G40.5, K86.00, O35.4, P04.3, X45	11	0.73	0.36-1.30	25	0.85	0.55-1.25

Table 11. Observed (Obs) numbers of deaths and standardized mortality ratios (SMR) with 95% confidence intervals (CI) among **female** Sami population with 75–100% of Sami ethnicity and among the non-Sami cohort members in 1979–2010. The standard population is the population of Finland (1.00)

Cause of death ICD 10	Sami women			non-Sami women		
	Obs	SMR	95%CI	Obs	SMR	95%CI
All causes 01-53, A00-R999	321	1.03	0.92-1.14	374	0.96	0.86-1.05
All diseases 01-41, A00-R99, X45	302	1.01	0.90-1.13	354	0.96	0.86-1.06
Infectious and parasitic diseases A00-B99, J65	3	1.14	0.24-3.34	2	0.59	0.07-2.12
Tuberculosis A15-A19, B90, J65	0			2	1.90	0.23-6.86
Malignant neoplasms C00-C97	65	1.07	0.82-1.36	67	0.73	
Endocrine, nutritional and metabolic diseases E00-E99	6	1.25	0.46-2.73	12	1.92	0.99-3.36
Diabetes mellitus E10-E14	5	1.18	0.38-2.75	12	2.24	1.16-3.91
Dementia and Alzheimers disease F01, F03, G30, R54	30	1.17	0.79-1.67	38	1.36	0.96-1.87
Other diseases of the nervous system and sense organs G00-G29, G31.0-G31.1, G31.8-G62.0, G62.2-G72.0, G72.2-H95	6	1.25	0.46-2.72	7	0.93	0.37-1.91
Diseases of the circulatory system I00-I42.5, I42.7-I99	140	0.90	0.76-1.05	179	1.02	0.88-1.17
Ischaemic heart diseases (IHD) I20-I25	54	0.66	0.50-0.86	95	1.03	0.83-1.25
Other heart diseases excl. rheumatic heart diseases (OHD) I30-I42.5, I42.7-I52	30	1.77	1.19-2.52	28	1.55	1.03-2.23
Cerebrovascular diseases I60-I69	45	1.08	0.79-1.44	41	0.86	0.62-1.17
Other circulatory diseases I00-I15, I26-I28, I70-I99	11	0.73	0.36-1.29	15	0.89	0.50-1.46
Diseases of the respiratory system J00-J64, J66-J99	24	1.19	0.76-1.76	22	0.99	0.62-1.50
Pneumonia J12-J18, J84.9	13	0.93	0.49-1.58	6	0.43	0.16-0.93
Bronchitis and emphysema J40-J44, J47	4	1.35	0.37-3.46	10	2.38	1.14-4.37
Asthma J45-J46	2	2.12	0.26-7.66	2	1.56	0.19-5.62
Diseases of the digestive system K00-29.1, K29.3-K67, K71-K85, K86.1-K93	10	1.00	0.48-1.84	9	0.76	0.35-1.44
Diseases of the genitourinary system N00-N99	6	1.35	0.50-2.93	4	0.84	0.23-2.14
Alcohol related diseases and accidental poisoning by alcohol F10, 31.2, G40.5, K86.00, O35.4, P04.3, X45	1	0.36	0.01-2.03	7	1.10	0.44-2.25

Table 12. Observed (Obs) numbers of deaths and standardized mortality ratios (SMR) with 95% confidence intervals (CI) among **male and female** Sami population combined with 75–100% of North Sami, Inari Sami and Skolt Sami ethnicity cohort members in 1979–2010. The standard population is Finnish population (1.00).

Cause of death	North Sami			Inari Sami			Skolt Sami		
	Obs	SMR	95% CI	Obs	SMR	95% CI	Obs	SMR	95% CI
All causes 01-53	310	0.94	0.83-1.04	231	0.90	0.79-1.02	146	1.23	1.04-1.44
All diseases	271	0.88	0.78-0.99	204	0.85	0.73-0.96	131	1.20	1.00-1.41
Infectious and parasitic diseases A00-B99, J65	2	0.77	0.09-2.79	2	1.02	0.12-3.66	1	1.08	0.03-6.03
Tuberculosis A15-A19, B90, J65	0			1	1.32	0.03-7.37	1	2.49	0.07-16.35
Malignant neoplasms C00-C97	56	0.81	0.61-1.05	28	0.55	0.37-0.80	35	1.43	0.99-1.98
Endocrine, nutritional and metabolic diseases E00-E99	2	0.49	0.06-1.77	2	0.67	0.08-2.41	1	1.33	0.16-4.79
Diabetes mellitus E10-E14	2	0.56	0.07-2.02	1	0.38	0.01-2.09	2	1.51	0.18-5.46
Dementia and Alzheimers disease F01, F03, G30, R54	20	1.11	0.68-1.70	21	1.36	0.84-2.07	9	1.46	0.67-2.76
Other diseases of the nervous system and sense organs G00-G29, G31.0-G31.1, G31.8-62.0, G62.2-G72.0, G72.2-H95	4	0.80	0.22-2.04	4	1.16	0.32-2.97	0		
Diseases of the circulatory system I00-I42.5, I42.7-I99	134	0.86	0.72-1.01	112	0.88	0.73-1.05	61	1.10	0.84-1.41
Ischaemic heart diseases I20-I25	62	0.68	0.52-0.86	56	0.76	0.54-0.98	38	1.18	0.83-1.61
Other heart diseases excl. rheumatic heart diseases I30-I42.5, I42.7-I52	24	1.61	1.03-2.39	21	1.71	1.06-2.61	5	0.92	0.30-2.14
Cerebrovascular diseases I60-I69	40	1.14	0.81-1.54	30	1.03	0.70-1.47	15	1.18	0.66-1.94
Other circulatory diseases I00-I15, I26-I28, I70-I99	8	0.57	0.25-1.12	5	0.44	0.14-1.01	3	0.60	0.12-1.76
Diseases of the respiratory system J00-J64, J66-J99	25	0.99	0.64-1.46	21	0.98	0.61-1.49	11	1.25	0.63-2.24
Pneumonia J12-J18, J84.9	9	0.64	0.29-1.20	12	0.95	0.49-1.66	4	0.78	0.21-2.00
Bronchitis and emphysema J40-J44, J47	10	1.25	0.60-2.30	6	0.94	0.35-2.05	6	2.33	0.85-5.06
Asthma J45-J46	2	2.76	0.33-9.96	2	3.64	0.44-13.16	0		
Diseases of the digestive system K00-29.1, K29.3-K67, K71-K85, K86.1-K93	8	0.93	0.40-1.83	2	0.29	0.04-1.04	3	0.96	0.20-2.81
Diseases of the genitourinary system N00-N99	8	2.18	0.94-4.30	3	0.95	0.20-2.78	1	0.76	0.02-4.24
Alcohol related diseases and accidental poisoning by alcohol F10, 31.2, G40.5, K86.00, O35.4, P04.3, X45	5	0.59	0.19-1.36	4	0.93	0.25-2.38	2	0.60	0.07-2.15

Table 13. Observed (Obs) numbers of deaths from diseases and malignant neoplasms and standardized mortality ratios (SMR) with 95% confidence intervals (CI) among **male** Sami population with 75–100% of Sami ethnicity and non-Sami population 1979–2010. The standard population is Finnish population (1.00).

Site ICD 10	<u>Sami men</u>			<u>Non-Sami men</u>		
	Obs	SMR	95% CI	Obs	SMR	95% CI
Total deaths	412	0.96	0.87-1.04	614	1.08	1.00-1.16
A00-R999						
All diseases	338	0.86	0.77-0.95	517	1.04	0.95-1.13
A00-R99						
Malignant neoplasms	62	0.68	0.52-0.87	151	1.20	1.02-1.40
C00-97						
Oesophagus C15	0			4	1.46	0.40-3.74
Stomach C16	6	0.84	0.31-1.82	11	1.20	0.60-2.14
Colon C18	2	0.43	0.05-1.55	2	0.32	0.04-1.14
Rectum C20-C21	2	0.63	0.08-2.28	6	1.42	0.52-3.09
Liver C22	1	0.38	0.01-2.10	1	0.26	0.01-1.42
Pancreas C25	0			10	1.21	0.58-2.21
Larynx, Bronchus, Lung	22	0.81	0.51-1.22	49	1.26	0.93-1.66
C32-C34						
Prostata C61	5	0.39	0.13-0.90	23	1.59	1.01-2.38
Kidney C64	1	0.36	0.01-2.02	6	1.44	0.53-3.12
Bladder C67	1	0.35	0.01-1.96	5	1.49	0.48-3.47
Lymphatic tissue C81-C96	6	0.76	0.28-1.65	12	1.06	0.55-1.85

Table 14. Observed (Obs) numbers of deaths from diseases and malignant neoplasms and standardized mortality ratios (SMR) with 95% confidence intervals (CI) among **female** Sami population 75–100% ethnicity and non-Sami population 1979–2010. The standard population is Finnish population (1.00).

<u>Site</u> ICD 10	<u>Sami women</u>			<u>Non-Sami women</u>		
	Obs	SMR	95%CI	Obs	SMR	95%CI
Total deaths	321	1.03	0.92-1.14	374	0.96	0.86-1.05
A00-R999						
All diseases	302	1.01	0.90-1.13	354	0.96	0.86-1.06
A00-R999						
Malignant neoplasms						
C00-C97	65	1.07	0.82-1.36	67	0.73	0.56-0.92
Oesophagus C15	1	0.87	0.02-4.81	0		
Stomach C16	5	1.10	0.36-2.57	5	0.83	0.27-1.93
Colon C19	3	0.67	0.14-1.94	6	0.96	0.35-2.08
Rectum C20-C21	1	0.47	0.01-2.60	3	1.01	0.21-2.94-
Liver C22	3	1.66	0.34-4.85	0		
Pancreas C25	8	1.58	0.68-3.11	5	0.67	0.22-1.57
Larynx, Bronchus, Lung						
C32-C34	5	0.98	0.32-2.28	10	1.19	0.57-2.18
Breast C50	2	0.21	0.03-0.76	11	0.67	0.34-1.20
Cervix 53	3	3.10	0.64-9.06	1	0.68	0.02-3.81
Uterus C54-C55	1	0.53	0.01-2.96	2	0.72	0.09-2.59
Ovario C56	9	2.50	1.14-4.74	10	1.66	0.80-3.06
Kidney C64	2	1.15	0.14-4.15	0		
Bladder C67	1	1.22	0.03-6.77	0		
Lumphatic tissue C81-C96	3	0.48	0.10-1.40	4	0.43	0.12-1.10

The cancer mortality of the Sami men was significantly lower than that of the general population, SMR 0.68 (95% CI 0.52–0.87) (Table 10). The difference is largely attributable to prostate cancer, SMR 0.39 (0.13–0.90), colon cancer, SMR 0.43 (0.05–1.55), and pancreatic cancer, SMR 0.35 (0.04–1.28). The cancer mortality of the non-Sami men was significantly elevated. That was attributable to prostate cancer, SMR 1.59 (1.01–2.38) and several non-significantly increased cancers e.g. oesophagus-, stomach-, rectum-, lung-, kidney- and urinary bladder cancer. (Table 13)

The mortality from breast cancer among Sami women was low, SMR 0.21 (0.03–0.76), while mortality from ovarian cancer was elevated, SMR 2.50 (1.14–4.74) (Table 14).

The Skolt Sami had high mortality from stomach cancer; in 1979–1987 the SMR was 6.29 (2.04–14.68). It later decreased, and in 2006–2010 there were no deaths, hence the SMR for the whole time studied 1979–2010 was 3.72 (1.50–7.66). SMR for all malignant diseases among Skolt Sami men was 1.66 (1.04–2.51) and that of the Skolt women 1.15 (0.61–1.97). Mortality from the group of “other malignant neoplasms”, which includes malignancies of the nervous system, connective tissue, bone and endocrine system, was significantly elevated among Skolt Sami men, SMR 5.33 (2.30–10.50).

The SMR for ischemic heart disease (IHD) among the Sami men in 1979–2010 was 0.87 (0.71–1.03) and among the women 0.66 (0.50–0.86) (Tables 10 and 11). The SMR for ischemic heart disease among the North Sami women was significantly decreased, 0.48 (0.28–0.77). Mortality from “other heart diseases” (OHD) was significantly elevated among both the Sami women, SMR 1.77 (1.19–2.52) and the non-Sami women SMR 1.55 (1.03–2.23) but not among the men. The SMR for IHD of the Sami women did not change from the first study period 1979–1987 (SMR 0.66, 0.37–1.09) to the last one 2006–2010 (SMR 0.56, 0.21–1.21), but there was a relative decrease in SMR for OHD from 2.47 (1.41–4.01) in 1979–1987 to 0.50 (0.01–2.80) in 2006–2010. There was no change over time in the SMR of the Sami men.

The non-Sami women showed significantly increased mortality from diabetes, SMR 2.24 (1.16–3.91). That was not the case for the Sami women (Table 11). The Sami men had no deaths from diabetes (Table 10).

Mortality from diseases of the respiratory system among the Sami did not differ from that among the whole Finnish population. Deaths from bronchial asthma were statistically insignificantly increased among North- and Inari Sami. SMR among North Sami was 2.76 (0.33–9.96) and among Inari Sami 3.64 (0.44–13.15). There were no deaths from asthma among Skolt Sami. Bronchitis and emphysema as a cause of death were significantly increased among the non-Sami women. It was also increased among the Sami, but not significantly, SMR 2.33 (0.85–5.06). Pneumonia as the cause of death was decreased, SMR 0.78 (0.21–2.00).

The SMR for the group of diseases of the digestive system was not different from

that of the general population. The same is true for diseases of the genitourinary system. The SMR for the group of “alcohol related diseases and accidental poisoning of alcohol” was low among both genders, and the SMR among the Sami men was 0.73 (0.36–1.30).

5.1.2 ACCIDENTS AND SUICIDES

Mortality from accidents and violence was significantly increased among the Sami and the non-Sami men (Table 15). The SMR for accident and violence was not significantly increased among the Sami women, 1.22 (0.71–1.94). Both the Sami and the non-Sami men had significantly elevated mortalities from “other land transport accidents,” which in Lapland mainly refers to snowmobiles. Both categories of men also had highly significant SMRs for water transport accidents. The SMR for water transport accidents and drowning among the Sami were significantly increased, especially among Inari Sami, the corresponding SMRs being 9.67 (1.99–28.25) and 6.22 (1.28–18.16). There were also water transport accidents among the non-Sami, but not drowning. The suicide mortality of the Sami men was significantly elevated, SMR 1.78 (1.14–2.65) and of the Sami women slightly elevated 1.26 (0.34–3.21), while those of the non-Sami men and women were not.

Table 15. Observed (Obs) numbers of deaths from accidents and violence and standardised mortality ratios (SMR) with 95% confidence intervals (CI) among the Sami males with 75–100% of Sami ethnicity and Non- Sami cohort members in 1979–2010. The standard population is Finnish population (1.00). (Codes and ICD 10 Statistics Finland 2005).

Code ¹	Cause of death (ICD 10)	Sami (Group 1)			Non-Sami (Group 3)		
		Obs	SMR	95% CI	Obs	SMR	95% CI
42-53	Accidents and violence Excluding accidental poisoning of alcohol	72	1.84	1.44-2.31	91	1.28	1.03-1.57
42-49	Accidents total V01-X44, X46-Y862	43	1.88	1.36-2.52	63	1.62	1.25-2.07
42	Land traffic accidents ²	8	1.74	0.75-3.43	12	1.39	0.72-2.42
43	Other land transport ³	7	17.2	6.90-35.4	5	6.20	2.01-14.5
44	Water transport accidents V90-V94	10	8.22	3.94-15.1	9	3.77	1.72-7.15
46	Accidental fallings W00-W19	7	0.84	0.34-1.72	10	0.91	0.44-1.67
47	Drowning W65-W74	6	3.52	1.33-7.86	7	2.17	0.87-4.47
48	Accidental poisoning X40-44, X46-49, Y10-15 excl. alcohol	2	0.93	0.11-3.34	4	0.89	0.24-2.28
49	Other accidents	2	2.12	2.26-7.66	15	1.89	1.06-3.11
50	Suicides X60-84, Y87.0	24	1.78	1.14-2.65	25	0.93	0.60-1.37

¹ 53 coded longitudinal cause-of-death categories based on revisions of ICD-8, ICD-9 and ICD-10 (Statistics Finland 2005).

² **1996-1997:** V01-V06(.1), V09 (.2-.3, .9), V19.9, V29.9, V39.9, V49.9, V59.9, V69.9, V79.9, V81-V83.3, V84-V86 (.3) **1998:** V01-V06 (.1), V09.2-V09.3, V10-V18 (.4-.9), V19(.4-.6, .9), V20-V28(.4-.9), V29 (.4-.6, .9), V30-V38 (.5-.9), V39(.4-.6, .9), V40-V48(.5-.9), V49 (.4-.6, .9), V50-V58 (.5-.9), V59(.4-.6, .9), V60-V68(.5-.9), V69 (.4-.6, .9), V70-V78 (.5-.9), V79(.4-.6, .9), V81.1, V82.1, V83-V86(.0-.3), V87, V89.2-V89.3

³ **1996-1997:** V01-V06(.0, .9), V09 (.0-.1, .9), V19.2, V29.2, V39.2, V49.2, V59.2, V69.2, V79.2, V80, V83-V85 (.9), V89.90-V8698, V89 **1998:** V01-V06 (.0, .9), V09 (.0-.1, .9), V10-V18 (.0-.3), V19(.0-.3, .8), V20-V28(.0-.3), V29 (.0-.3, .8), V30-V38 (.0-.4), V39(.0-.3, .8), V40-V48(.0-.4), V49 (.0-.3, .8), V50-V58 (.0-.4), V59(.0-.3, .8), V60-V68(.0-.4), V69 (.0-.3, .8), V70-V78 (.0-.4), V79(.0-.3, .8), V80.0-V81.0, V81.2-V82.0, V82.2-V82.9, V83-V86(.4-.9), V88, V89(.0-.1, .9)

⁴ W20-W64, W75-X39, X50-X59, Y85-Y86

5.2 CANCER INCIDENCE (II)

5.2.1 CANCER OF SAMI AND NON-SAMI

The observed number of cancer cases was 109 among the Sami and 222 among the non-Sami in the Study II (Table 16). A new follow-up until 2010 was done, and hence the figures are given for the whole time period 1979–2010. There were 98 more cancers for the Sami and 218 for the non-Sami, altogether 207 and 440 respectively.

The SIR for the total cancer of the Sami for the whole period 1979–2010 was significantly decreased (Table 16). For the same period, the SIR for the Sami males was significantly decreased when compared to the Finnish general population 0.63 (95% CI 0.51–0.75) (Appendix 5). The corresponding SIR for women was 0.77 (0.63–0.92) (Appendix 6). Also, the SIR for non-Sami was significantly decreased in 1979–2010. The ratio of the SIRs of Sami and non-Sami is, in spite of that, significantly decreased, too.

The incidence of lung cancer in 1979–2010 among the Sami was almost on the same level as the national average, (Table 16), but that of non-Sami was in 1999–2010 significantly increased. The combined SIR for other tobacco related cancers (larynx, oesophagus, tongue, oral cavity, pharynx, pancreas, kidney and bladder) was slightly decreased 0.78 (0.58–1.03), but not significantly. A significantly decreased SIR among the Sami but no decrease among the non-Sami was found for cancer of the bladder, ureter and urethra.

The incidence of breast cancer was significantly low among Sami and non-Sami in the study area. The ratio of their SIRs is low, but not significantly. Ovarian cancer showed a significantly increased risk among the non-Sami. The excess among the Sami women was non-significant (Table 16).

The trend of the SIR for the prostate cancer among the Sami was increasing, but it is still remained significantly below the national average. Among the non-Sami the corresponding figures did not differ from those of the general Finnish population. There were decreasing number of individual cases in the group “unspecified digestive organs” among Sami and non-Sami. That group, C26 (ICD 10) includes cancer of the spleen and undefined intestinal cancers.

The SIR for basal cell carcinoma of the skin was low among the Sami and the non-Sami. The difference between the Sami and the non-Sami, to the benefit of the former, was statistically significant in 1979–1998, but not later (Table 16). The Sami had no cases of Hodgkin’s lymphoma or multiple myeloma.

Table 16. Observed (Obs) numbers of cancer cases and standardized incidence ratios (SIR) with 95% confidence intervals (CI) among the Sami with 75–100% of Sami ethnicity and among the non-Sami cohort members during the periods 1979–1998, 1999–2010 (the updated period after paper II) and 1979–2010. **Males and females** combined. The standard population is the Finnish population (1.00).

Site ICD 10	Time period	<u>Sami</u>			<u>Non- Sami</u>			<u>Sami/non-Sami</u>
		Obs	SIR	95% CI	Obs	SIR	95% CI	Ratio of SIRs
All	1979-1998	109	0.64	0.53-0.76	222	0.92	0.80-1.10	0.70 (0.55-0.88)
C00-96	1999-2010	98	0.76	0.62-0.93	218	0.87	0.76-1.00	0.87 (0.68-1.11)
	1979-2010	207	0.69	0.60-0.78	440	0.90	0.82-0.98	0.77 (0.65-0.91)
Stomach	1979-1998	13	1.20	0.61-2.0	16	1.21	0.69-1.97	
C16	1999-2010	3	0.81	0.17-2.36	5	0.75	0.24-1.75	
	1979-2010	15	1.04	0.58-1.71	21	1.10	0.65-1.61	0.99 (0.47-2.01)
Colon	1979-1998	6	0.63	0.23-1.37	9	0.72	0.33-1.36	
C18, C19	1999-2010	9	1.19	0.54-2.26	13	0.94	0.50-1.60	
	1979-2010	15	0.88	0.49-1.44	22	0.83	0.52-1.25	
Unspecified digestive organs	1979-1998	8	10.4	4.49-20.5	3	4.35	0.90-12.7	
	1999-2010	2	4.65	0.56-16.8	2	2.99	0.36-10.8	
C26	1979-2010	10	8.29	3.98-15.2	5	3.68	1.20-8.59	2.25 (0.70-8.38)
Lung	1979-1998	22	0.94	0.59-1.4	35	1.10	0.77-1.5	0.85 (0.48-1.50)
C32-C34	1999-2010	10	0.84	0.40-1.54	25	1.14	1.74-1.68	0.74 (0.32-1.59)
	1979-2010	32	0.91	0.62-1.27	60	1.11	0.85-1.43	0.81 (0.51-1.27)
Breast	1979-1998	7	0.37	0.15-0.76	24 ¹	0.84	0.54-1.25	0.44 (0.16-1.06)
C50	1999-2010	7	0.40	0.16-0.81	26	0.65	0.42-0.95	0.61 (0.22-1.45)
	1979-2010	14	0.38	0.21-0.64	50	0.68	0.51-0.89	0.57 (0.29-1.04)
Ovary	1979-1998	6	1.82	0.67-3.96	11 ¹	2.03	1.02-3.64	0.89 (0.27-2.64)
C56	1999-2010	3	1.47	0.30-4.30	7	1.59	0.64-3.28	0.93 (0.16-4.06)
	1979-2010	9	1.69	0.77-3.21	18	1.83	1.09-2.89	0.92 (0.37-2.16)
Prostate	1979-1998	5	0.25	0.08-0.59	18 ¹	0.79	0.47-1.24	0.32 (0.09-0.90)
C61	1999-2010	9	0.38	0.17-0.72	42	0.99	0.71-1.33	0.39 (0.17-0.80)
	1979-2010	14	0.32	0.18-0.54	60	0.92	0.70-1.17	0.35 (0.18-0.64)
Kidney	1979-1998	3	0.51	0.11-1.51	9	1.06	0.48-2.01	0.49 (0.09-1.96)
C64	1999-2010	2	0.49	0.06-1.78	4	0.52	0.14-1.32	0.95 (0.09-6.64)
	1979-2010	5	0.51	0.16-1.18	13	0.80	0.43-1.36	0.63 (0.18-1.89)
Bladder, ureter, urethra	1979-1998	2	0.28	0.03-1.03	12 ¹	1.34	0.69-2.34	0.21 (0.02-0.95)
	1999-2010	2	0.45	0.05-1.61	6	0.77	0.28-1.68	0.58 (0.06-3.23)
C66-C67	1979-2010	4	0.35	0.09-0.88	18	1.08	0.64-1.70	0.32 (0.08-0.98)
Thyroid gland	1979-1998	1	0.43	0.01-2.42	4	² 0.92	0.25-2.37	0.47 (0.01-4.75)
C73	1999-2010	2	1.28	0.16-4.63	5	1.39	0.45-3.24	0.92 (0.09-5.64)
	1979-2010	3	0.78	0.16-2.27	9	1.13	0.52-2.15	0.69 (0.12-2.75)

The numbers are slightly different from those in the publication II, because of the additional checking of the data.

¹Observed number has changed, ² expected number has changed.

5.2.2 CANCER OF SUBCATEGORIES OF SAMI

During the period studied, the total incidence of cancer was significantly lower among North Sami, Inari Sami, and mixed Sami (SIR 0.67 (95% CI 0.48–0.91)) and non-Sami than among the entire Finnish population. The incidence of stomach cancer among Skolt Sami was significantly increased, especially in the beginning of the study period. Some other cancers were also increased among Skolt Sami, but not significantly. Such cancers were those of pancreas, gall bladder and bile ducts, unspecific digestive organs, lung and brain cancer (Table 17). The Skolt Sami had no cases of oesophagus, ovary, prostate, bladder, ureter, urethra or thyroid cancer.

Table 17. Observed (Obs) numbers of cancer cases and standardized incidence ratios (SIR) with 95% confidence intervals (CI) among the Sami subgroups, North Sami, Inari Sami and Skolt Sami with 75–100% of Sami ethnicity 1979–2010. **Males and females** combined. The standard population is Finnish population (1.00).

Site ICD code	North Sami			Inari Sami			Skolt Sami		
	Obs	SIR	95% CI	Obs	SIR	95% CI	Obs	SIR	95% CI
All sites C00-96	94	0.68	0.55-0.82	53	0.57	0.43-0.74	48	0.96	0.71-1.27
Oesophagus C15	1	0.65	0.02-3.63	0			0		
Stomach C16	5	0.78	0.25-1.81	1	0.21	0.01-1.15	8	3.40	1.47-6.69
Colon C18-19	7	0.89	0.36-1.83	1	0.21	0.01-1.15	1	0.35	0.01-1.96
Rectum C 19-21	3	0.56	0.12-1.64	4	1.08	0.29-2.77	1	0.52	0.01-2.90
Liver C22	1	0.52	0.01-2.88	1	0.74	0.02-4.14	1	1.50	0.04-8.35
Pancreas C25	6	1.16	0.43-2.52	0	-	-	3	1.60	0.33-4.67
Gallbladder bile ducts C23-24	1	0.59	0.01-3.26	1	0.78	0.02-4.34	2	3.08	0.37-11.12
Unspecific digestive organs C26	2	4.08	0.49-14.8	4	9.25	2.52-23.69	4	21.2	4.77-54.2
Lung C32 C34	12	0.75	0.39-1.30	8	0.69	0.30-1.36	9	1.63	0.75-3.09
Breast C50	8	0.47	0.20-0.91	3	0.29	0.06-0.85	3	0.42	0.09-1.22
Ovary C56	5	2.03	0.66-4.74	4	2.57	0.70-6.58	0		
Prostate C61	1	0.12	0.003-0.67	2	0.27	0.03-0.96	0		
Bladder, ureter, urethra C66-67	3	0.57	0.12-1.67	1	0.26	0.01-1.45	0		
Brain C71, 72	5	1.09	0.35-2.54	0			5	2.85	0.93-6.65
Thyroid gland C73	2	1.07	0.13-3.86	1	1.03	0.03-5.72	0		
Basal cell carcinoma of the skin C 44	4	0.13	0.04-0.33	4	0.20	0.05-0.50	5	0.46	0.15-1.06

The risk for stomach cancer among North Sami and Inari Sami was low, although the difference vs. the national average remained statistically insignificant. It had been low already in the early part of the study period. Thus the SIR for North Sami in 1979–1998 was 0.87 (0.24–2.22) and in 1999–2010, 0.55 (0.01–3.0), the corresponding figures for the Inari Sami being 0 and 0.94 (0.02–5.26), respectively, while the figures for Skolt Sami were 4.00 (1.61–8.24) and 1.67 (0.05–9.2), respectively.

Ovarian cancer showed a significantly increased risk among the non-Sami and Inari-Utsjoki total population, SIR 1.75 (1.16–2.53). The risk also seems to be increased among the North and Inari Sami, but not significantly. The Skolt Sami had no cases of ovarian cancer during the study period.

When the SIRs of all cancer sites were examined over 6 time periods (of length 5, 5, 5, 5, 6 and 6 years) among different Sami subgroups, the SIR among the North Sami increased, among the Inari Sami there was no change and among the Skolt Sami, an unequivocal decrease was found. Among the Inari-Utsjoki population, the SIRs for breast, prostate, and skin basal cell cancer were lower than those among the Finnish general population.

The lowest SIRs of total cancer during the above 5-year periods were found among the Inari Sami. The highest ones were found among the Skolt Sami during the first 4 time periods and the lowest ones during the two last 5-year periods. A significantly increased risk among male Skolts was found for cancer of the brain and the nervous system, based on 4 observed cases (SIR 5.45 (1.49–13.95)). No such elevated risk was observed in the other subgroups. The SIR for basal cell carcinoma of the skin was relatively low among all Sami groups, especially among the North Sami, SIR 0.13 (0.04–0.33).

5.3 COMPARISON OF THE INCIDENCE AND MORTALITY OF CANCER AMONG THE NORWEGIAN, SWEDISH AND FINNISH SAMI POPULATIONS (III)

The motive of this sub-study was to compare all cancer mortality and morbidity studies in Northern countries. Until 2008 (the year of publication) there were 4 publications concerning mortality and 4 publications concerning cancer.

5.3.1 MORTALITY

The SMRs in Table 18 show that all cancer mortality of all Sami men was significantly lower than that in their reference populations. It was 0.69 (95% CI 0.52–0.90) in Finland, 0.87 (0.79–0.95) in Sweden and 0.86 (0.79–0.94) in Norway. The SMR

of Norwegian Sami women was also significantly low (0.89 (0.80–0.99)), while the SMR of Swedish and Finnish Sami women was similar to that in their reference populations.

Table 18. Comparison of the standardized mortality ratios (SMR) with 95% confidence intervals (95% CI) of the total cancer among Sami in Finland, Sweden and Norway.

<u>Country</u>	<u>Men and Women</u> <u>SMR (95% CI)</u>		<u>Study</u> <u>period</u>	<u>Reference group or</u> <u>population</u>	<u>Reference</u>
	SMR Men	SMR Women			
Sweden	0.70 (0.56-0.87)		1961-1984	Sweden	Wiklund 1991
Finland	0.69 (0.52-0.90)	0.95 (0.70-1.25)	1979-1998	Finland	Soininen et al 2008
Finland	0.68 (0.52-0.87)	1.07 (0.82-1.36)	1979-2010	Finland	Soininen in this study
Sweden	0.87 (0.79-0.95)	1.06 (0.96-1.18)	1961-2000	Non-Sami matched for gender, age and area of residence	Hassler et al 2005
Norway	0.86 (0.79-0.94)	0.89 (0.80-0.99)	1970-1998	Three Northern municipalities	Tynes et al 2007

5.3.2 CANCER INCIDENCE

The incidence of the all-site cancers was lower than that in the respective reference populations among all Sami except Swedish Sami women (Table 19).

The SIRs of stomach cancer among Swedish Sami men and women were 1.23 (95% CI 1.01-1.50) and 1.53 (1.13–2.01), respectively. Among Finnish and Norwegian Sami, the SIRs of stomach cancer were close to 1, slightly lower than that among men and slightly lower among women.

The SIR for breast cancer among Finnish Sami was significantly low (0.45 (0.23–0.78)) while it was 0.85 (0.71–1.01) among Norwegian Sami. Among Swedish Sami, it was at the national level (Study III, Table II).

The SIR for lung cancer was significantly low among Norwegian Sami men (SIR 0.63 (0.51–0.77)) and women, SIR 0.60 (0.37–0.91).

The SIR for colon cancer was significantly low among both genders of Norwegian Sami and among Swedish Sami men (Study III, Table II). The SIR for colon cancer among Finnish Sami women was 1.40 (0.60–2.75).

Table 19. Comparison of the standardized incidence ratios (SIR) with 95% confidence intervals (95% CI) of cancer of all sites among Sami in Finland, Sweden and Norway.

Country	Men and Women SIR (95% CI)		Study period	Reference population	Reference
	Men SIR (95% CI)	Women SIR (95% CI)			
Sweden	0.61 (0.05-0.75)		1961-1984	Population of Sweden	Wiklund et al 1991
Sweden	0.69 (0.56-0.83)		1961-1984	Population of Umeå	Wiklund et al 1991
Finland	0.64 (0.53-0.76)		1979-1998	Population of Finland	Soininen et al 2002
Finland	0.71 (0.58-0.84)	0.89 (0.72-1.09)	1979-2006	Population of Lapland	Hassler et al 2008
Finland	0.63 (0.51-0.75)	0.77 (0.63-0.92)	1979-2010	Population of Finland	Soininen unpublished
Sweden	0.56 (0.47-0.67)	0.68 (0.53-0.86)	1961-1997	Population of Sweden	Hassler et al 2001
Sweden	0.78 (0.57-0.89)		1961-1997	Geographically and demographically. Matched non – Sami population	Hassler et al 2001
Sweden	0.90 (0.85-0.96)	1.04 (0.97-1.10)	1961-2003	Geographically and demographically. matched non – Sami population	Hassler et al 2008
Norway	0.78 (0.73-0.84)	0.84 (0.78-0.91)	1970-1997	Non-Sami in the same Sami municipalities	Haldorsen et al 2005

Among the Finnish and Norwegian men and Swedish women, the SIR for bladder cancer was significantly low. The SIR for the bladder cancer in Finnish men was 0.24 (0.03–0.85) and women 1.36 (0.28–3.96).

Prostate cancer was significantly rare in all Sami groups compared with respective reference populations (Study III, Table II).

The incidence of all-site cancer in the three countries and their Sami populations increased during the respective time periods. (Study III, Figure 1). The cancer incidences of the general populations are close to each other in all three countries

and clearly higher than the incidence figures among the respective Sami populations. The cancer incidences of Sami men are similarly running lower than that of the general populations in Finland, Sweden and Norway, but among women the cancer incidence of Swedish Sami is the same as that of the Swedish general population. The incidence figures of all-site cancer among Norwegian and Finnish Sami are approaching those among the respective national populations.

5.4 CANCER SURVIVAL (IV)

There were 204 cancer cases in the Sami cohort and 391 in the non-Sami cohort. The number of controls was 20,181 when cancer patients were matched with respect to site, gender, age at diagnosis and year of diagnosis, and 7,874 when also matched with respect to stage. Survival during the first 5 years after diagnosis was first compared without considering the stage and then also matching for stage. In the cancer-specific analysis without the stage variable, the hazard ratio was 1.05 (95% CI 0.85–1.30) for the Sami and 1.02 (0.86–1.20) for the non-Sami. When the Sami cancer patients were also matched according to the stage of the cancer, the cancer-specific analyses gave a hazard ratio of 1.02 (0.78–1.33) for the Sami and 1.10 (0.91–1.33) for the non-Sami. The hazard ratios in the all-cause 5-year survival analysis were 1.13 (0.94–1.37) for the Sami and 0.97 (0.84–1.12) for the non-Sami. In the survival curves (Study IV, Figure 1.) a small deficit can be seen in the Sami survival compared with the matched controls. This difference, however, is not statistically significant. The survival curves for the non-Sami and matched controls are practically identical.

6 DISCUSSION

6.1 MATERIAL AND METHODS

6.1.1 THE STUDY COHORT AND ETHNICITY

The Sami cohort consists of 82% of the Sami in Inari-Utsjoki if calculated from the number of the Sami in 1975 (3224) (Karjalainen et al 1979 and in section 2.1.2) and if calculated from all Sami, the cohort represents 66% of the Finnish Sami living in Sami Homeland. The definition of the Sami has changed from time to time, and the number of Sami has often been an estimation, except in the study of Nickul (1968), in which an actual enumeration of the Sami population was conducted. Today, according the last definition of the Sami (see 2.1.2), their number outside the Sami Homeland is 6460 and inside 3459.

Those Sami who are missing from the cohort probably belong to the group 2 (1–74% of Saminess). This has hardly any influence on the results in studies I and II and their updatings, because the latter results pertain to the group 1 (75–100% Saminess). Study III included all Sami, but the estimated number of missing Sami is not high and has hardly introduced significant bias to the results. Locating those persons who have only some Saminess is difficult, since they may have not a Sami name any more, they may not speak Sami and may not have been enrolled in the IBP/HA study. In that case, it is possible that they have ended up to the non-Sami cohort.

The classification of the Sami living in Inari into three subtypes was based on the data of the International Biological Program, which is based on language, genealogy and identification of persons with his/her family and relationships and through interviewing (see section 4.1, Nickul K 1948, Nickul E 1968, von Bonsdorff et al 1974). The latter database used in more than 100 genetic and other studies can be regarded as reliable.

The weakness of the cohort is its small size and the strength is the “pureness”, because the mixing of the Sami with others in the Finnish population is going on with accelerating speed. The Sami are usually handled as one group, but the Sami consist of several different groups that may have different disease patterns, and this is why the Sami subgroups were here studied separately. The present cohort was constructed at the end of 1978, hence it is getting “old” and young age groups are missing. It may have caused bias to the occurrence of diseases, accidents and violence prevalent among young people.

Sami ethnicity in Nordic countries and Russia.

Ethnicity is not registered in the Nordic countries, and the national register information is not always available or suitable for scientific research (Lund et al 2008, Norum et al 2011). Because of that, there are different ways to get around the problem, either by using the statistics of Sami municipalities (Näyhä 1997), asking the persons themselves their ethnicity (Forsdahl et al 1979, Näyhä et al 1993, Tverdahl 1997, Lund et al 2008, Pettersen et al 2013) or to use some other register, e.g. the register of reindeer herders, complementing it by using other registers and thereby creating the final the study population (Wiklund et al 1990, Hassler et al 2005, Kurttio et al 2010). Haldorsen et al (2005) used the Norwegian population census of 1970 when a survey of Sami ancestry was made, and ethnicity was also asked the persons themselves.

Because of the different ways to define the Sami identity, it is important to take this into consideration when comparing results from different studies (Lund et al 2008). In addition to the definition of the Sami group, the reference group should be taken into account while comparing the standardized incidence rates SIRs and standardized mortality rates SMRs in Northern countries.

In the Finnish results, the SIRs of Studies II and III differ from each other. The results in Study III were higher. The cohort in that study consist of mixed Sami, group 2 (1–74% of Saminess) together with the group 1 (75–100% of Saminess), like in Swedish and Norwegian studies where the percentage of the Saminess is not taken into account, but instead, all Sami are included in the studies. The reference group was also different, i.e. the population of the Hospital District of Lapland. In Study II, the reference group for the Sami and non-Sami was the population of Finland and the Saminess more than 75%. The influence of the standard population is discussed in connection with cancer mortality (6.2.2).

In Russia it was traditionally self-evident to count the different ethnic groups, but it ended in 1990s (Dudarev 2013). In the censuses, the mother tongue was asked. The Lovozero county of Murmansk province is the area where most of the northern indigenous peoples, among them the Sami, were collected in the 1920s and 1930s to start the living in kolkhozes (Lukjantschenko 1989). In 1995 there were 940 Sami (Kaminsky 1996).

Comparison of the Sami cohorts in Finland, Sweden and Norway.

In Study III, varying definitions of Saminess may have had influence on the results. The composition of the Sami cohorts differed. The Finnish and Norwegian Sami groups came primarily from the Sami area. The Finnish cohort was small, but the Saminess was well defined and they were living in the Sami Homeland. The

Norwegian cohort was large, and it has been living in the Sami area in northern Norway. It has been possible to live in a more traditional way in the rural area. The Swedish cohort was state-wide and collected from different Sami registers. It is not restricted to the Sami area, and it is not known where the Sami are living today. Possibly, many of the non-reindeer herding Sami were living in the southern parts of Sweden and the reindeer herding Sami had stayed in the Sami area in the north. The Swedish Sami cohort was surprisingly large, and it is possibly the southernmost cohort when compared to the Finnish and Norwegian Sami cohorts, hence the reference population could belong to the Swedish general population and Swedish northern population (Figure 27). The living habits of the Swedish cohort are likely the most westernized or resemble most the living habits of the Swedish main population. Today in all these countries, a part of the Sami are living much the same way as the main population and a part of the non-Sami in the Sami Homeland are living like the Sami.

6.1.2 DATA QUALITY

The reliability of diagnoses

The mortality diagnoses were usually ante mortem clinical diagnoses. Of the diagnoses, 12% in Inari and 13% in Utsjoki were based on autopsies in 1961–1990 (Näyhä 1997). The forensic autopsy rate in Lapland concerning suicides was 71% in the 1970s, 95% in the 1980s 98% in the 1990s and 100% in 2001–2005 (Näyhä 2009). When the death of a person is violent, the police order a forensic autopsy if it is needed (THL 2013). The number of medical autopsies has decreased in Finland from 24% in 1975–1980 to 5% in 2013. Forensic autopsies have increased during the same time from 15% to 25% (Valvira 2013).

The ante mortem diagnostic skills of physicians have improved and new medical equipment has been developed, and hence the number of clinical autopsies has decreased. Stenbäck (1986) compared the clinical diagnoses to the autopsy-diagnoses and found that the clinical diagnosis of coronary heart disease in Oulu University Hospital in the 1980s was usually reliable, but a lack of correct ante mortem diagnosis of “other heart diseases” was relatively common. The diagnosis “cardiac insufficiency” which was commonly used previously, belongs to the group “other heart diseases”, and it is an unspecific diagnosis.

In Finland, every deceased person must receive a death certificate. In practice, the coverage of the cause of death statistics is slightly less than 100 per cent.

The cancer diagnoses and the histological definitions are practically always made by central hospital specialists and pathologists. Cancers can also be found post mortem during autopsy, but there is no data about that from Lapland. The

possibility to get medical consultation is rather easy for everybody. Because the rate of cancer has increased, people are aware of it and watch for possible signs of cancer. They also get good medical care if a diagnosis is made. The results of Study IV support this view.

Registers used

Three registers were used in this study, the National Cause-of-Death Register, the Finnish Cancer Register and the National Population Register. The national mortality records trace back to 1749. From 1936 they have been based on the compulsory medical death certificate (Act:459/1973). Cancer registration started from 1953. The data in those registers has good coverage and validity (Teppo et al 1994). In 1961 the National Board of Health issued a by-law making reporting compulsory.

In Statistics Finland, the underlying cause of death used in statistics (statistical underlying cause of death) is determined according to the selection and application rules of the International Classification of Diseases (ICD-10) compiled by the World Health Organisation (Statistics Finland 2010).

In other Nordic countries, the mortality- and cancer registers are similar to the Finnish registers, and they also have lifetime personal identification numbers. Among various countries, only the United States consistently provides health data on their indigenous population (American Indians, and Alaska natives or AI/AN). In Alaska, the Alaska Native Tumour Registry (ANTR) has collected cancer data since 1969. In Canada, the cancer incidence reporting system also started in 1969. The Canadian Cancer registry receives cancer data from all provincial and territorial cancer registries where internal record linkage of cancer patient data and the national death register are combined annually. It then returns the data to the contributing registries. (Young et al 2008). In the Russian Arctic, there are local registers and official regional registers (Kaminsky 1996). In Chukotka, the time period of 1961–1990 was a time of relatively stable Soviet health care and statistical reporting in the region. The collapse the USSR in 1991 was accompanied by disruption of government services. From the beginning of 2002, statistical data specific to indigenous people were no longer collected (Dudarev et al 2013). In Murmansk oblast (district) the grouping of indigenous peoples and others was “Natives” and “Russians”. The Sami, the Komi and the Nenets were included as natives of the Kola Peninsula in the 1990s.

Before the starting years of the registers in Arctic areas, no systematic data on cancer existed. There were only individual reports often made by medical doctors from their working area, or scientists had conducted field work among indigenous

people or used the information of patient registers (Hildes et al 1984, Hubert et al 1984, Kaminsky 1996, Dudarev et al 2013).

In conclusion, the registers in Finland and Nordic countries are reliable enough for the present purpose, and the personal identity code makes it easy to link registers on an individual basis. The computerized record linkage procedures are practically error-free and a calculation of various statistical indices (incidence, standardized incidence, mortality, survival) are established procedures and have been routinely used for years. (Teppo et al 1994, Pukkala 1992) Therefore, it is highly unlikely that any shortcomings in the definition of the study cohorts, the follow-up procedures or calculations would have introduced bias the results.

6.2 THE MORTALITY OF THE SAMI (I, III)

6.2.1 MORTALITY AS AN INDICATION OF HEALTH AND DISEASE

Measuring the pattern of mortality in a population is a time-honoured approach to assessing the health status of a population, although it should be emphasized that death represents only the severest consequence of ill health. Information on deaths is relatively easy to obtain, and death is final, unequivocal and occurs only once for each person (Young et al 2008). For a long time, mortality statistics have been the only and the best way to find out about the main diseases in a population and follow the changes in disease occurrence. Mortality statistics are used in this study to get information about the diseases of the Sami. The official mortality data are created in Statistics Finland according to the underlying cause of death. All deceased Sami in this study had received a medical death certificate. This is important, because in Greenland in 1975 and 1976, for example, almost 20% of deaths did not have a death certificate (Bjerregaard 1988).

6.2.2 TOTAL MORTALITY

In this study, the total mortality of the Sami in 1979–2010 did not differ significantly from the total mortality in the whole of Finland. Still in 1979–87, the standardized mortality ratio (SMR) of the Sami men was significantly below that for Finland. After that time, the low disease mortality of the Sami men has been counteracted by the high number of violent deaths. The total mortality of non-Sami men in the same area is increased. In 1961–1980, the low mortality in the three Sami municipalities has been noticed (Näyhä 1987). The low mortality of Sami is seen in the crude death rates of Inari municipality since 1840, excluding the wartime and the periods of the Spanish disease in 1911–1920 (Table 1).

In Figure 24, the mortality indice of the Social Insurance Institution (Kela

Mortality indice NTO79A) shows that the mortality in Utsjoki until the change of the millennium was clearly below the Finnish average. After some years, since 2005 it has been low again. The age adjusted mortality indice of Inari has been above the Finnish average since 1990.

The total mortality of North Sami and Inari Sami was slightly below the national average, but that of Skolt Sami was significantly higher than that. Harsh living conditions and poverty are the likely reasons for the higher mortality among the Skolt Sami. Apparently, the high Skolt Sami mortality also reflects delayed epidemiological transition (Omran 1971) among this special population group.

The progression of diseases sometimes takes years or decenniums, and that is why the reasons for causes of diseases and death should be looked at from the past of the individuals and populations. Stomach cancer is a typical disease that has its origin in times when the living standard was low and there was lack of adequate nutrition and knowledge about the risk factors. The incidence and mortality of stomach cancer among Finnish men born in 1900 is about ten-fold higher than that of men born in 1940 (Pukkala et al 2013). The Skolt Sami represent the generations exposed to lack of almost everything, especially things like food and vitamins. When this study started, stomach cancer was common among the Skolt Sami, but it has decreased during the period studied. The Skolt Sami had a low living standard after they were forced to leave their home district because of the war. They spent the wartime in quite strange circumstances in houses of foreign people, and in 1949 they got new homes in Sevettijärvi and Nellim (Koutonen 1972, Nickul 1948). During their evacuation and settlement in 1940–1949, 8% of the Skolt children aged 1–15 years died, while the corresponding figure for the Swedish Sami was 3.6 per cent (Lewin et al 1971).

Mortality in other Arctic areas

The Russian Sami minority had a much higher mortality than the Russian general population, because their living standard was also poor, and they were moved from their former places that had good fishing possibilities (Kaminsky1996).

When the mortality and other statistics are compared between Arctic Native populations, it is good to notice how different the circumstances in the Arctic are in different parts of the world. In Nordic countries we talk about long distances, but where the distance from the South of Finnish Lapland to the North of Lapland is about 400 km, the distances in Alaska can reach 800 km. The same concerns Arctic Canada and Arctic Siberia. The network of roads is also denser in Nordic countries.

Contrary to Nordic countries, the mortality of other indigenous peoples in the Arctic is significantly high when compared to the general population mortality in respective countries. Decades ago, mortality from cancer was low among Arctic

indigenous people, but it has increased later on. Mortality from tuberculosis and other infectious diseases has been so high that the life expectancy of the Greenlandic population rose from about 30 in the 1950s to over 60 in less than 20 years (Harvald 1972). Thus, this is one reason for the low number of cancer deaths in the 1950s.

6.2.3 DISEASE MORTALITY

Cancer mortality

It was expected that cancer incidence and mortality of the Sami and other population in northern municipalities would be elevated because of radioactive and chemical fallouts, which in northern districts tend to concentrate via food chains to the reindeer meat (Caesium-137) and fish (mercury and the lipid soluble pollutants). There was no evidence that high consumption of fish and reindeer meat could have had any increasing effects on cancer mortality. As seen in Figure 13, the amount of reindeer meat eaten by Sami men has been very high in the study by Jokelainen (1965) and in the study of reindeer herders in the 1980s (Näyhä et al 1993). For all Sami and non-Sami, the consumption of fish has been and still is high. In Nordic countries traditional foods of the Sami, which do not have significant amounts of pollutants any more, are recommended in the future, too.

The cancer mortality was significantly low among all Sami men in Nordic countries and also among Norwegian Sami women (Table 18), but among the Finnish and Swedish Sami women, it was not low when compared to the standard populations (Hassler et al 2005, Tynes et al 2007, Hassler et al 2008).

The mortality of Sami women in Study I was not significantly different from that of the main population, but the mortality of ovarian cancer was significantly high, and the SMRs for several cancers exceeded unity. Although the latter excess failed to reach statistical significance, these cancers increase the total mortality. On the other hand, the SMR for breast cancer was significantly low compared with the national level.

The North Sami and Inari Sami had very low cancer mortality rates. On the contrary, the Skolt Sami had a high cancer mortality, which however did not significantly exceed the national figures. The excess was due to increased mortality from stomach cancer and “other cancers”. The Skolt Sami had no deaths from cancers of oesophagus, colon, rectum, prostate, urinary bladder, breast or uterine cervix. These differences between the Sami subgroups are not seen if the Sami are treated as one group.

The mortality of cancer in the Nordic countries is declining. The mortality of the “all site cancer in standard populations of Sami Finland, Norway and Sweden is seen in Figure 27. The mortalities of all those populations are converging (Nordcan 2014).

The majority of Swedish Sami are supposed to live in the northern parts of Sweden, but a bigger part than in other countries may live in southern parts of Sweden. The reference population is a demographically matched non-Sami population, and hence they can live in any place in Sweden. The difference of mortality curves of northern Sweden and of the whole country is rather small, and therefore it is not necessary to know where the Swedish Sami live when they are compared with Sami in other countries. Of course the living standard and living habits can be different in the South and the North. The Norwegian Sami and their standard population are located in the North (Haldorsen et al 2005, Tynes et al 2007).

The influence of the standard population to the calculated SMRs of the Sami is easier to perceive if the time trends of the cancer mortality of different standard populations are seen (Figure 27). The standard population of the mortality study of the Finnish Sami is the population of Finland, that of Norwegian Sami is the northern (NO) rural population of Norway and that of Swedish Sami can be northern Swedish (SE) Swedish population (reindeer herding Sami) and the population of Sweden (possibly a part of non-reindeer herding Sami).

The mortality of cancer of “all sites” among the above mentioned standard populations from 1954 to 2010 are seen in the NORDCAN graphs in Figure 27. The study periods for Swedish Sami was 1961–2000, Norwegian 1970–1998 and Finnish 1979–2010 (Table 18).

The SMR of the Finnish Sami men is lowest because the expected incidence of the reference population is highest (Table 18, Figure 27). The mortality of the corresponding Norwegian reference population of Sami males is running between that of Finnish and Swedish curves from 1980 on. Before that time, the Norwegian and Swedish curves were close each other. The SMR of the Norwegian Sami males should be somewhat lower than that of the Swedish Sami males.

The “all sites”-cancer mortality curves of the reference populations of women in Finland, Sweden and Norway and their northern parts are rather close. It means that the SMRs of all sites cancer of the Sami women are rather comparable.

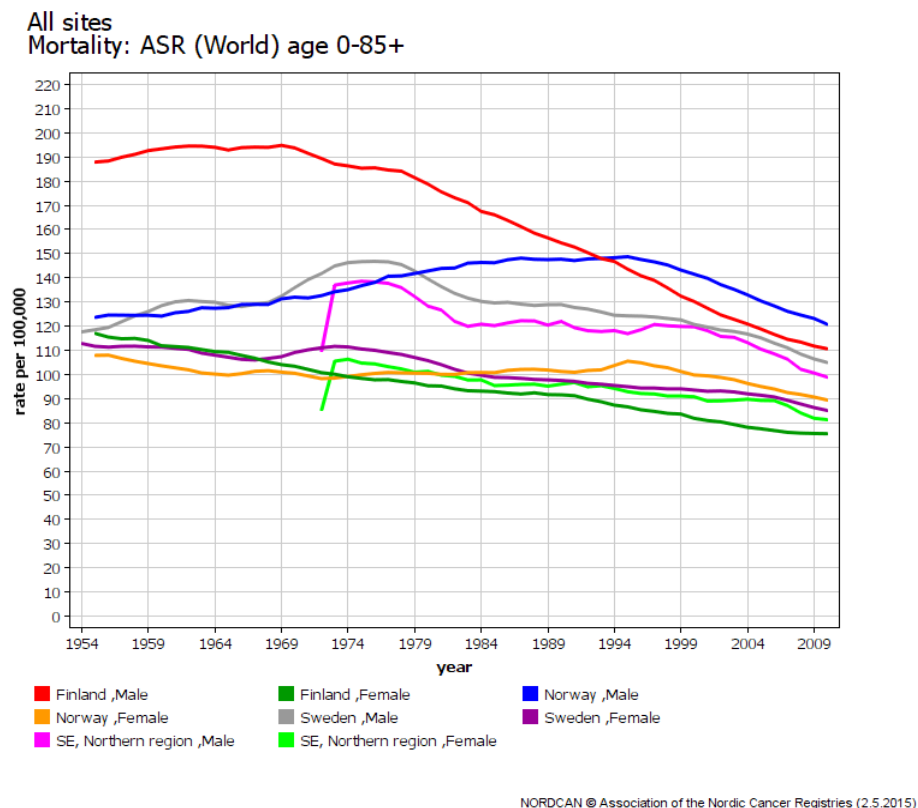


Figure 27. The all sites cancer mortality of the standard populations of Finland, Sweden (SE) and Norway and the northern region of Sweden. Men and women. The cancer mortality diagrams of men and women of Northern Norway are running close to those of whole Norway (NORDCAN 2014).

In Table 20, the SMRs of arctic indigenous populations are compared. In all studies in which the genders are given differently, the SMR of women is higher. Globally and also in Europe the mortality and incidence of all sites cancer is higher among men (GLOBOCAN 2012).

The health situation and cancer incidence and mortality of the Sami in Finland, Sweden and Norway are quite different from those of the Inuits in other Arctic countries. The Sami achieved already years ago the same living standard as other people in their countries. Also, health education (and education generally) and prevention of diseases have concerned the Sami in the same way as the majority. The health care system is also the same and practically free for everybody in Nordic countries. The situation among Sami in Lovozero, Kola Peninsula, Russia is different. Their traditional livelihoods ended in the 1930s when they were moved to one place (Lovozero) from their former scattered situated living places and got a new living style. The cancer mortality of the native people of Lovozero (about 50% are Sami)

is much higher than that of the Russians who live in the same region. Among men especially the mortality from stomach and pancreas cancers and among women cancers of the genital organs are several times higher (Kaminsky 1996, Chashin et al 1994).

Table 20. Comparison of the standardized mortality ratios (SMR) with 95% confidence intervals (95% CI) of cancer deaths of all sites among Sami population in Sweden, Finland and Norway, Russia and in other Arctic areas among Native people. For Natives and non-Natives in Lovozero mortality, (deaths/100,000 person years) is given.

Population	SMR (95% CI) Men	SMR (95% CI) Women	Time period	Reference group or population	Reference
	Men and women				
Sami Sweden ¹⁾	0.70 (0.56-0.87)		1961-1984	Population of Sweden	Wiklund 1991
Sami Finland ¹⁾	0.69 (0.52-0.90)	0.95 (0.70-1.25)	1979-1998	Population of Finland	Soininen et al 2008 ¹⁾
Sami Finland	0.68 (0.52-0.87)	1.07 (0.82-1.36)	1979-2010	Population of Finland	Soininen updated 2010
Sami Sweden	0.87 (0.79-0.95)	1.06 (0.96-1.18)	1961-2000	Demographically matched non-Sami population	Hassler et al 2005
Sami Norway	0.86 (0.79-0.94)	0.89 (0.80-0.99)	1970-1998	Population of three Northern municip. in Norway	Tynes et al 2007
Greenland Inuits	1.0 (0.9-1.1)	1.3 (1.2-1.4)	1968-1985	Population of Denmark	Bjerregaard 1988
Greenland Inuits	1.63 (1.58-1.68)		2000-2004	Population of Denmark	Young et al 2008
Alaska Native and Indians (Inuits, Aleuts Indians)	1.27 (1.10-1.45))		2000-2004	US White population	Young et al 2008
Alaska Native and Indians	1.16 (1.04-1.29)	1.31 (1.19-1.46)	2004-2008	US White population	Holck et al 2013
Nunavut Inuits	2.06 (1.86-2.28)		2000-2004	Population of Canada	Young et al 2008
NWT Canada Inuits	1.19 (1.04-1.37)		2000-2004	Population of Canada	Young et al 2008
Kivalliq Canada Inuits	1.92 (1.73-2.14)		1987-1996	Population of Canada	Young et al 2008
Chukchi in Chukotka Russia	2.01 (1.95-2.07)	3.64 (3.53-3.77)	1961-1990	Population of Russia	Dudarev et al 2013
Chukchi inChukotka Russia	1.06 (1.02-1.11)	1.37 (1.15-1.63)	1997-2010	Population of Russia	Dudarev et al 2013
Natives ¹ in Lovozero	507	252	1968-1992	deaths / 100,000 person years	Chashin et al 1994
Non-natives Lovozero	343	103	1968-1992	deaths/100,000 person years	Chashin et al 1994

¹ Natives in Lovozero in 1994 were Sami (940), Nenents (171) and Komi (1269) (Kaminsky 1996).

6.2.3 MORTALITY FROM DISEASE OF CIRCULATORY SYSTEM

Cardiovascular diseases (CVD)

The total cardiovascular disease mortality among the Finnish Sami was at about the same level as that of the general population. The mortality from ischemic heart disease (IHD) of the Sami men and women was lower, the latter statistically significantly, than that of the general population. Mortality from other heart diseases (OHD) was statistically significantly higher among Sami men and women than the general population. The low occurrence of IHD among the Sami is in line with the comment of former provincial medical officer Aino Yliruokanen (personal communication 1986), who performed autopsies on Sami people in the 1960s. She told that the arteries of the Sami were quite without sclerosis and looked very sleek and healthy. In the study of Finnish reindeer herders, the Sami reindeer herders had less heart disease, past heart infarctions and hypertonia, and fewer of them used medication for circulatory diseases than other reindeer herders in Finland (Näyhä et al 1993).

The group of OHD includes infections of the heart muscle and pericardium, valvular diseases, several non-infectious diseases of the myocardium and their post-infectious states, conduction disorders and arrhythmias, heart degenerations, cardiac arrest, insufficiency of the heart and other poorly-classified and non-specific heart failures. This group of diagnoses has possibly been used if there were no signs of IHD, but some cardiac signs. The diagnoses of OHD may have been inaccurate even in central hospitals (Stenbäck 1986). The pattern for the non-Sami woman was similar, but non-Sami men had low SMRs of OHD (0.66 (0.35–1.12)). If IHD and OHD are combined, the SMR for Sami men is 0.92 (0.77–1.09) and women 0.86 (0.68–1.06). The indice of cardiac insufficiency in Inari and Utsjoki is higher than the indice for whole Finland (Figure 29). It fits well with the observation of high mortality of OHD.

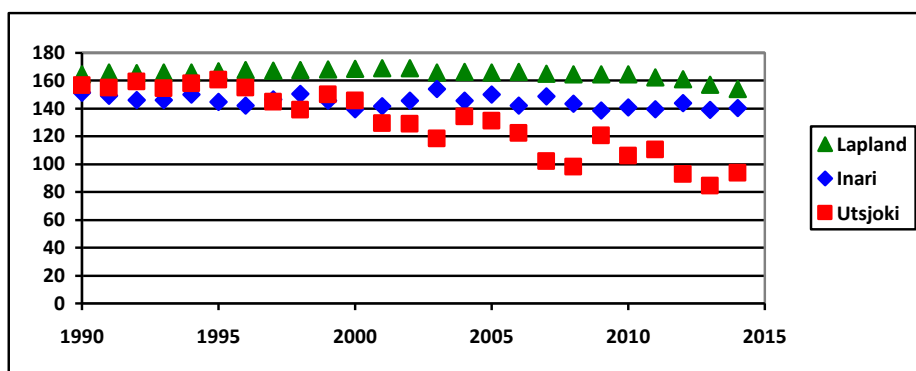


Figure 28. Indices¹⁾ of cardiac insufficiency of Inari and Utsjoki and whole Lapland in 1990–2014 as compared to the annual rate of Finland (100) (Kela health barometer). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1).

¹⁾The index is calculated of the entitled reimbursement for the medication of cardiac insufficiency. Description of the index is in chapter 2.3.5.

http://raportit.kela.fi/approot/lisatied/NIT083A_en.html)

The Norwegian Sami men and women also had significantly increased SMRs for “other” heart diseases (Tynes et al 2007). The diagnosis of heart disease in an old person, especially IHD of a woman, is not easy (Kaaja 2003). Similar to our finding from northern Finland, mortality from OHD among Arctic Native populations in Sweden, Alaska, Canada and Greenland was higher than among the non-Native comparison population (Wiklund 1991, Bjerregaard et al 2003, Young et al 1993). IHD has been found to be traditionally rare among indigenous populations in the North and also among the Sami (Wiklund 1991, Näyhä 1997, Forsdahl et al 1979, Tverdahl 1997, Luoma et al 1995, Edin-Liljegren et al 2004) and the Inuit (Bjerregaard 1988, Bjerregaard et al 1988, Bjerregaard et al 2003, Young et al 1993, Young 1994).

Hassler et al (2005) found that the SMR for IHD among reindeer-herding Sami men was 0.95 (0.84–1.07) and among women 1.07 (0.77–1.45). The corresponding numbers among non-reindeer herding Sami were 1.04 (0.96–1.12) and 1.19 (1.07–1.31). The change of occupation seems to have an influence on IHD. It usually means that the way of living changed towards that of the main population.

Recently in Norway, Eliassen et al (2014) have assessed the age-specific prevalence of self reported angina pectoris symptoms among the rural population of northern Norway in 2003–2004. The response rate was 60.1%, and in the final analysis there were 5187 Sami and 10,019 non-Sami. The prevalence of self-reported angina pectoris was among Sami men 11.7% (95% CI 10.5–13.0) and women 9.0% (7.9–10.2). The corresponding prevalence among non-Sami was 8.3 (7.5–9.2) and 6.2% (5.5–6.9).

The high occurrence of infectious diseases and the lower one of IHD can be seen as consequences of delayed epidemiologic transition (Omran 1971) among the Sami and other Arctic peoples. The studies of Hassler et al (2005) and Eliassen et al (2014)

also conform to this assumption. In addition to living habits, the westernization and mixing with the main population may be the reason for the change. That seems to happen earlier in Sweden and Norway.

The reasons for the low occurrence of IHD among the Sami are not clear, because it is not explained by the traditional risk factors. The Sami have a high serum concentration of total cholesterol and triglycerides, a higher than average body mass indice, and smoking among them is common with 34% of Sami reindeer herders in 1986–88 being smokers (Näyhä et al 1993). Blood pressure has generally been low, and diabetes is a rather new phenomenon among the Finnish Sami. In the study of Eliassen et al (2014), the established risk factors explained little or none of the ethnic variation in symptoms of angina pectoris. In women, however, less moderate alcohol consumption and leisure-time physical activity of Sami was thought to explain the entire ethnic difference.

The traditional Sami food consisted of fish, game, reindeer and berries, and later potatoes and some vegetables and dairy products (Jokelainen 1965, Nilsson et al 2011). Fatty fish may have been more important than reindeer meat for the Sami of southern Lapland in Sweden in the 1930s–1950s (Nilsson et al 2011). Still in 1988, the average Sami diet contained significantly more protein, fat, niacin, vitamin B12, iron, zinc, selenium, cholesterol, sodium and less carbohydrates, calcium, disaccharides and fibre as compared with the Swedish diet (Håglin 1991).

When concentrations of antioxidants (alfa-tokopherol, retinol, albumin and selenium) in the blood of the Sami were studied, there was an association between alpha-tocopherol and the number of reindeer meat meals per week. The serum selenium concentration was positively associated with the number of fish meals per week (Luoma et al 1995).

Chlamydia pneumonia and *Helicobacter pylori* have been associated with arteriosclerosis (Laurila et al 1997). The Finns were more often chlamydia seropositive than the Sami, 76% versus 67%. The observation was similar regarding the IgG and IgA antibodies of *Helicobacter pylori*.

It has been stated that physical exercise has a preventive influence on IHD risk factors (blood lipids, blood pressure, blood clotting, obesity, diabetes and diseases of the connective tissue and blood vessels) and, hence, on IHD (Laukkanen et al 2003). The earlier way of life of the Sami has been much more physically demanding, especially that of the nomadic Sami. Karlsson (1970) reported data for the maximal oxygen uptake of Skolts in Nellim in Finland and found that their fitness was lower than what Andersen reported about nomadic Sami. The same was stated by Sundberg (1976) among Inari Sami, North Sami and Skolt Sami. The change in the level of fitness of other than nomadic Sami occurred in the 1960s or before. The decrease of physical exercise had diminished among the Swedish Sami (Edin-Liljegren et al 2004). There was no difference between Sami and non-Sami. There was a small difference between reindeer-herding Sami and non-reindeer-herding Sami, the former being more physically active. The Kela-indice for IHD in figure 29

shows that the IHD indice of Utsjoki has been below the general level since 1990 and likely also earlier. That is in line with the significantly low IHD mortality of North Sami and Inari Sami, but the Skolt Sami had slightly, but non-significantly increased IHD mortality, as did the non-Sami.

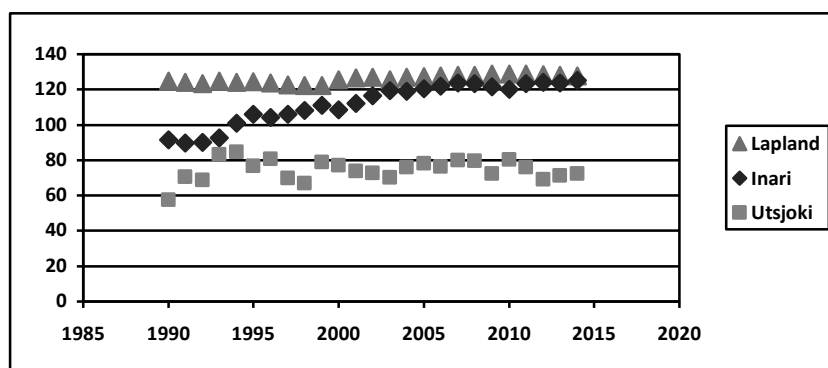


Figure 29. Indices¹⁾ of Ischaemic heart disease (IHD) of Inari and Utsjoki and whole Lapland in 1990–2014 as compared to the annual rate in Finland (100) (Kela Health barometer 2015). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1)

¹⁾ The index is calculated of the entitled reimbursement for the medication of ischemic heart disease. Description of the index is in chapter 2.3.5.

http://raportit.kela.fi/approot/lisatied/NIT083A_en.html

The IHD indice of Inari is approaching the level of Lapland, which in turn is higher than that of whole Finland. That could be called “the first stage of the increasing living standard”, which means that when it becomes possible to buy whatever food, travel by car, get alcohol and other stimulants easily, people really use them until they discover that in spite of their many possibilities, everybody must make choices for themselves. The classic example of food culture change is the increased obesity of Pima Indians and the resulting diabetes and its consequences, among others coronary heart disease (Bennett et al 1971, Knowler et al 1981).

Cerebrovascular diseases (CVD)

The SMR for cerebrovascular diseases among Norwegian Sami in 1970–1998 was significantly increased among men and women (Tynes et al 2007). Among the Finnish and Swedish Sami SMRs of cerebrovascular diseases did not deviate from unity. The SMR for subarachnoid haemorrhage (SAH) was significantly increased in 1961–2000 among Swedish Sami for both men, SMR 1.60 (1.02–2.38) and women, SMR 1.54 (1.02–2.24) (Hassler et al 2005). In another study of Swedish Sami 1985–2001 (Sjölander et al 2005) the corresponding SMRs were 1.57 (0.84–2.69) and 1.44 (0.69–2.65). In this material, all those Sami, who were related to non-Sami were excluded from the study. The authors thought that SAH might be a hereditary

condition among the Swedish Sami. The occurrence of SAH has not been studied among Norwegian and Finnish Sami.

Arterial thrombosis is the principal mechanism in cerebrovascular diseases, subarachnoid haemorrhage (SAH) accounting for only 5% of them. Aneurysms are the cause of subarachnoid haemorrhage in 85% of cases and in 50% of cases of spontaneous SAH the underlying cause is a rupture of a cerebral aneurysm (van Gijn et al 2007). The risk factors for SAH are smoking, hypertension, excessive alcohol intake and non-white ethnicity (Fågelholm et al 1987, Pfohman et al 2001, Feigin et al 2005).

Genetic factors underlying SAH involve family history and the presence of certain inheritable connective tissue disorders. A third risk factor is blood coagulation disturbance. This was observed among Inuits during the period when their food consisted almost solely of arctic marine mammals and fish (Bang et al 1980, Kromann et al 1980, Young 1986, Bjerregaard et al 1988). When strokes in Greenland were analysed later in 1999–2002, they consisted mostly of infarctions, and only a minority of them were intracerebral haemorrhages (Kjaergaard et al 2003).

6.2.3 MORTALITY FROM RESPIRATORY DISEASES

Respiratory disease

Respiratory disease mortality of the Finnish Sami did not differ from that of the Finnish general population, but the non-Sami women showed a statistically significant excess of deaths from smoking-related diseases such as bronchitis, emphysema and chronic obstructive pulmonary disease. That is in line with smoking habits observed in Finnish Lapland. The proportion of female smokers aged 45–54 years in Lapland was 30% in 2002. That is the highest in Finland when compared to the other Finnish women of the same age (Laatikainen et al 2003). Elevated SMR for respiratory diseases was also found among Swedish Sami, especially women (Hassler et al 2005) and among Norwegian Sami, both men and women (Tynes et al 2007)

Asthma

The use of medication for asthma in Lapland and Sami municipalities has slightly increased since 1990 (Figure 30). Deaths from asthma among Sami occurred only in age groups over 65 years, and SMR for asthma failed to differ significantly from the national level. The reasons for the common use of asthma medication in Inari and Utsjoki remains unknown. Asthma cannot be a very “old” disease among Sami. Living with bronchial asthma would have been very difficult in former times in the northern environment.

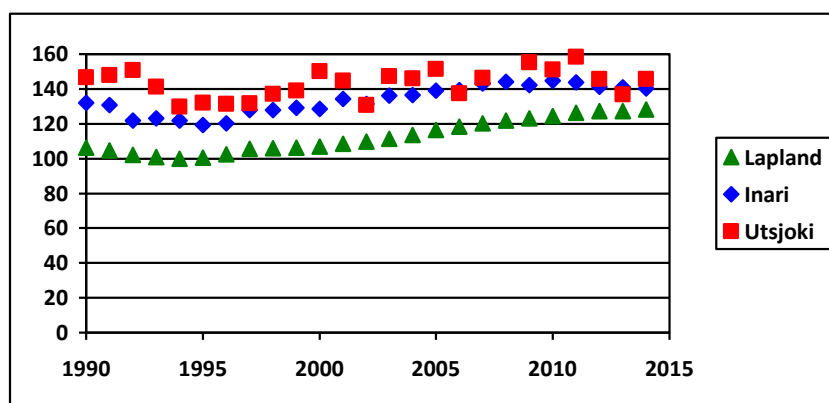


Figure 30. Index¹⁾ of asthma of Inari and Utsjoki and whole Lapland in 1990–2014 as compared to the annual rate in Finland (100) (Kela Health barometer 2015). The proportion of the Sami in Inari is about 30% and in Utsjoki 60–70% (Appendix 1)

¹⁾The description of the index is in chapter 2.3.5.

http://raportit.kela.fi/approot/lisatied/NIT083A_en.html http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NIT083AL&YKIELI=E

Kotaniemi (2002) has found that asthma is equally common in the north and in the south in Finland, in spite of the fact that cold air increases the signs of breathing difficulties. In recent years, the prevalence of asthma in Finland has been 6% (Harju 2012).

Asthma has been found to be common among children in the Norwegian Sami counties of Troms and Finnmark (Selnes et al 2005). Three cross-sectional questionnaire-based studies of asthma and allergies in school children aged 9–11 were conducted in these counties in 1985, 1995 and 2000. The prevalence of asthma was 9.3, 13.2 and 13.8% respectively. The prevalence of asthma increased in males from 1995 to 2000, but it decreased in females.

Diabetes

Diabetes is increasing all over the world. The mortality from diabetes among the Sami seems to be about the same level in Nordic countries, although it has slightly increased. The Finnish Sami males form an exception, because in the present study, none of them died from diabetes. The choice of the main cause of death may be different in different countries, and it may have caused bias to the comparison. Obesity and lack of physical exercise are important in the development of type 2 diabetes. The same that concerns asthma, also applies to diabetes: a person with diabetes could not manage in the wilderness. The etiological factors of diabetes, such as obesity and common infections, also may have been rarer in previous times. In Figure 22 the indices of diabetes in the Sami municipalities are below

the national average (Kela Health Barometer), and they have also been there before 1990 (Kirjarinta et al 1976).

In 1979, the Sami were at the upper limit of the normal weight indice (Forsdahl et al 1979), and in the 1980s, the Sami reindeer herders were slightly overweight (Näyhä et al 1993). According to the author's personal observations, diabetes among the Finnish Sami started to increase in the 1980s (Soininen unpublished).

Type 2 diabetes is a disease marked by significant changes over time. It has been a very rare among arctic indigenous people such as Inuits (Scott et al 1957, Schaefer 1968), and Athabaskan Indians (Mouratoff et al 1969). It is clear that in former times, a diabetic could not live long without medication in Arctic circumstances. Today, obesity has increased and physical exercise has decreased among many arctic peoples, and type 2 diabetes has increased.

In 1998, the prevalence of diabetes among Alaska Inuits was 28.3/1000 (Naylor et al 2003), but only 5/16,000 (0.3/1000) in the 1950s (Scott et al 1957). In Upernavik district in 1950–1974 in Greenland (population less than 2000), there was only one person with diabetic glucose tolerance (Kroman et al 1980). In 1983–85, Stepanova et al (1990) looked for diabetes among Chuchi in Russia. No frank diabetes was found, but glucose tolerance was impaired in 5% of the indigenous population and in 16% of newcomers.

Schulz et al (2006) have studied diabetes among Mexican Pima Indians and Pima groups living in the USA that share considerable genetic similarity relative to other Native Americans. They found that the age- and sex-adjusted prevalence of type 2 diabetes in the Mexican Pima Indians (6.9%) was less than one-fifth that in the U.S. Pima Indians (38%) and similar to that of non-Pima Mexicans (2.6%). The prevalence of obesity was similar in the Mexican Pima Indians (7% in men and 20% in women) and non-Pima Mexicans (9% in men and 27% in women) but was much lower than in the U.S. Pima Indians. Levels of physical activity were much higher in both Mexican groups than in the U.S. Pima Indians. The much lower prevalence of type 2 diabetes and obesity in the Pima Indians in Mexico than in the U.S. indicates that even in populations genetically prone to these conditions, their development is determined mostly by environmental factors, thereby suggesting that type 2 diabetes is largely preventable. That study provides evidence that changes in lifestyle associated with Westernization play a major role in the global epidemic of type 2 diabetes.

Dementia and Alzheimer's disease

The present study showed that dementia and Alzheimer's disease has been the main cause of death among the Sami rather often, but they have not increased to any significant extent. This applies to all groups in the area and might be caused

at least partly by classification. It is difficult to find the cause of death for a person who is very old and has no specific signs of diseases, but who only fades slowly away. 4.7% of the Sami men over 65 years of age had a diagnosis belonging to that group, and 95.3% of men over 75 years of age had a diagnosis of dementia. The corresponding figures for women were 6.6% and 93.4%. Most of these deaths had been allocated to the group senilitas (ICD 10 code R 54).

Alcohol related diseases

Mortality from alcohol related diseases and accidental alcohol poisoning was not increased among Sami, compared with the reference populations. The SMR of the Sami men was 0.62 (0.25–1.26) in 1979–2005 and later in 2006–2010 was 0.73 (0.36–1.30). The Sami reindeer herders use 19.6 g/day of alcohol (Poikolainen et al 1992), while the non-Sami reindeer herders use 11.4 g/day. In 2013, Finns over 15 years consumed 11.6 litres 100% alcohol (THL 2013). The corresponding figure in 1985 was 9.4 litres and 1990 11.0 litres.

6.2.4 ACCIDENTS

Mortality from accidents is common everywhere in the Arctic (Bjerregaard 1990, Middaugh 1992, Klen 1992, Bjerregaard 1992, Young KT et al 1992, Hassler et al 2004). The accident mortality was high in this study among both the Sami and the non-Sami men. The amount of fatal accidents among Sami men was 4 times that of the Sami women. The excess was the same for non-Sami men and women in the area. The risk of accidental death among Sami men is 1.9-fold and that among non-Sami men in the same area 1.6-fold compared with that for all men in Finland.

Snowmobiles and all-terrain vehicles contribute directly to the excess of “other land transport accidents”. The SMR for those accidents among Sami males is 17.2 (6.90–35.36) and non-Sami males 6.20 (2.01–14.47). Deaths in conjunction with transport by terrain vehicles and water transport and drowning make up a half of all accidental deaths among men. The number of terrain vehicles has increased. According to the snowmobile register in 2003, there were 113 snowmobiles per 1,000 inhabitants in Lapland (Köngäs 2004). The terrain vehicles that are used outside the public roads are not registered, and that’s why their exact number is not known, but their amount increased in the 1980s as did the accidents, too (Pekkarinen et al 1988). It was estimated in 1990 that the number of snowmobiles could be 30,000 in Lapland (the population of Lapland in the same year was 181,500, hence 1 snowmobile per 6 persons) (Soininen et al 1992). The number of registered terrain vehicles in 2013 in Inari Utsjoki was 4680 (Lahtinen 2014).

17% of the fatal traffic accidents in Lapland during the years 1989–1992 were snowmobile accidents (Soininen 1994). The corresponding number in this study among Sami men was 16%. When the fatal snowmobile accidents in Lapland were analysed closer, it was found that in half of the accidents the driver was under the influence of alcohol (Soininen et al 1994). Kõngäs (2006) stated in his report on the snowmobile accidents in Finland that the fatal accidents occur mainly under the influence of alcohol. The amount of fatal accidents per snowmobile has not increased, because people have recognized the dangers of driving terrain vehicles (Kõngäs 2006).

Snowmobile accidents also account partly for drownings, because people often drive onto bodies of water that are insufficiently frozen. 65% of fatal snowmobile accidents in Finland occur on ice, and 65% of those fatalities are drownings (Kõngäs 2004). Snowmobile driving is common in regions where snow covers the ground most of the year, and the snowmobile is an important tool in reindeer herding.

The risks of the reindeer herding work in Finland have been the target of research for several decades. In the interview study of accidents of reindeer herders in 1986 and 1988, the accidents were analysed (Pekkarinen et al 1988, Pekkarinen et al 1992). The incidence of accidents during the year preceding the interview (1985 and 1987) was 4.2 per 1000 working days. The corresponding number for Sami reindeer herders was 3.2/1000. Young age and less than 20 working days per year were risks. Among those whose main occupation was reindeer herding, the incidence was lowest, i.e. 2.6 /1000.

In 1990, all snowmobile accident visits to 18 health centres and 3 hospitals were analysed (Soininen et al 1992). The number of accidents was 290 and the number of injuries 371. 13% of the patients were reindeer herders, 9% lumbermen and hunters and 3% policemen or soldiers. A total of 24% of the accidents were work-related. Of all the injured drivers, 78% had more than one year driving experience.

Other risk factors of reindeer herding work are frost bite (Ervasti et al 1993), musculoskeletal syndromes and symptoms of locomotive organs (Näyhä et al 1991, 1994), vibration-induced white finger syndrome (Anttonen et al 1994) and noise-induced hearing problems (Anttonen et al 1994).

The Swedish reindeer-herding Sami men had the SMR of 7.34 (95% CI 3.16–14.5) for snowmobile and other terrain vehicle accidents during 1961–2000 (Hassler et al 2003). When compared to other work related fatal accidents in Sweden, it was found that commercial reindeer management is one of the most dangerous occupations in Sweden. It is not always easy to determine the difference between work and leisure time among the Sami, and hence there is sometimes alcohol within the baggage.

The risk of dying in a boat accident was 8-fold for the Finnish Sami and 4-fold for the non-Sami as compared with the general population. The mortality from water transport accidents was elevated in all Sami groups, but was highest among the Inari Sami, also known as Fisher Sami. The Inari Sami fish in the large Inari

Lake, often even under hard weather conditions. The best fishing times are in the spring and autumn. During the autumn, the weather changes quickly, and storms can come up during a fishing trip. If the boat capsizes, swimming in the cold water is dangerous. Not only are the waters cold throughout the year, the Sami's swimming skills are poor, due to a shortage of experience of swimming in cold ponds and lakes. Children today have the possibility to learn to swim in the swimming pool, included in the school sports. Today everybody should have a life jacket. In spite of that, the only way to be safe is to go to the shore when the wind begins to blow. Boat accidents and drownings are also common in other Arctic areas (Hassler et al 2003, Bjerregaard 1992, Young 1992, Middaugh 1992).

Because of long distances and limited public transportation, people use private cars, that tend to be old and in poor condition in the remote areas. The SMR for the traffic accidents of Sami is 1.90 (0.98–3.31). Risk-taking behaviour has traditionally been common in Arctic areas, and this behaviour often applies to fatalities (Klen 1992).

6.2.5 SUICIDES

Suicides among the indigenous peoples in the Arctic were very rare before 1960, but they have increased during the recent decades (Bjerregaard 1988, Outakoski 1980, Seitamo 1980, Rodgers 1982, Lynge 1994, Bjerregaard et al 2004). Along with the breakdown of the traditional social community and culture, the numbers of suicides have increased, and they occur in all adult age groups. Earlier, many suicides among Inuits occurred among the old ones who, once they felt they had become a burden on society, decided to freeze to death out on the ice (Thorslund 1990). Nomadic life for old people was exceedingly difficult among the arctic Natives. In 1961–2005 the rate of suicides of men in Finnish Lapland has been significantly higher than the national average. The same is true for Inari and Utsjoki separately. The suicide mortality of women in Lapland has been significantly lower than in Finland generally (Näyhä 2009). In the present study, the pattern was the same for non-Sami women, but not the Sami women. The SMR for suicides of Sami women was insignificantly increased (1.26 (0.34–3.21)).

Sami men commit suicide at younger ages than men in Finland in general. In the present study, most suicides (42%) were committed in the age group of 30–44 years. Among men of the total Finnish population, suicides are most common in the age group 45–59 (30%) (Statistics Finland 2014). The suicides of women did not concentrate to any age groups.

Suicides among Finnish Sami have reportedly concentrated in two families who believed themselves to be predestined to suicide because their ancestors had done so many evil things that the following generations had to commit suicide (Outakoski 1980). One of the reasons for the hopelessness of young men may be

that many girls and women leave the community (Koutonen 1972). The Skolt Sami had the highest SMR for suicides. Their acculturation (Berry 1990) has not been easy (Koutonen 1972, Pelto 1973). The Orthodox religion of the Skolts may have once protected them from suicides (Seitamo 1980), but its influence in that sense has diminished. Skolts have had a very difficult life ever since the end the Second World War. They had to leave their traditional living area, their sempiternal fishing districts of the families, and they had to adapt themselves to a monetary society. They lost their reindeer during the war, and although they were given new herds, reindeer herding was not easy in the new area. Then, the so called “snowmobile revolution” disturbed their social and economic system (Pelto 1973). That has had an impact on their mortality in many ways.

Suicide mortality among Norwegian Sami in 1970–1998 was relatively high (SMR 1.27 (95% CI 1.02–1.56)). The reference population was the rural population of arctic Norway (Silviken et al 2006). Significantly increased suicide mortality was found among young Sami aged 15–24 years, both males (SMR 1.82 (95% CI 1.13–2.78)), and females (SMR 3.17 (1.17–6.91)). The age pattern is different from that observed among the Finnish Sami. In that study, significantly increased suicide mortality was also found among subgroups of indigenous Sami males (e.g. non-reindeer herding Sami).

6.3 CANCER AMONG THE SAMI (STUDY I, II, III)

The all-site cancer incidence among the Sami was found to be significantly lower than that of the main population in 1979–2010. This was also separately true for cancers of prostate, bladder (only men) and breast, and basal cell carcinoma of the skin. No individual cancer showed increased incidence compared with the reference population. Only the SIR for cancers of “other digestive organs” was relatively high among men and women. There were variations among different Sami groups.

In Finland, the Sami men had low incidence and low mortality of cancer. The Sami women had low incidence but mortality comparable to that of all Finns, except ovarian cancer, which showed relatively high mortality.

Cancer among Sami was compared to cancer among the Finnish general population and to that among non-Sami neighbours (Study II) and the Sami in Sweden and Norway (Study III). The Finnish figures have been updated until 2010. Study II concerned the time from 1979 to 1998. Most SIRs showed some excess over the national level, except that for the stomach, lung, brain, leukaemia, cervix uteri and the unspecified digestive organs, which were slightly lower than unity.

Most common cancers in 2011 in Finland were those of prostate, lung and colon in men and those of breast, colon and corpus uteri in women (Pukkala et al 2013).

Among Sami men the order is lung, prostate and stomach, and among Sami women breast, colon and ovary.

6.3.1 CANCER OF ALL SITES

The present study showed a significantly low overall cancer incidence among Finnish Sami. Similar results were reported by Kurttio et al 2010. Thus, among the 2037 Sami subjects born in Sami municipalities (Enontekiö, Inari, Utsjoki, Sodankylä and Petsamo), the SIR versus the incidence among the people of Oulu University Hospital district was 0.60 (0.50–0.71). It is slightly lower than the respective SMR in this study (0.69 (0.60–0.78)), but the follow-up started earlier (1971) and ended earlier (2005).

In the study cited above, the corresponding SIR for all people born in the Sami municipalities was 0.86 (0.82–0.89). In Study II, the incidence of total cancer among non-Sami was also significantly low, with SIR of 0.90 (0.82–0.98). However, the ratio of Sami vs. non-Sami was 0.77 (0.60–0.97). The low level of cancer among the non-Sami population in the north may be caused by some environmental factors. Why the corresponding incidence was even lower among the Sami remains unknown, but some unidentified genetic properties could be entertained as reasons.

As expected, the incidence patterns by cancer site among North Sami, Inari Sami and Skolt Sami differ in details, but the incidence of all site cancers among the subgroups of Sami is similarly low, except the Skolt Sami because of their high stomach cancer incidence. The Sami groups are genetically and culturally different and are therefore expected to show different cancer patterns (Eriksson et al 1974, Eriksson et al 1988). The stages of cancer development, with different steps from cell mutation to cancer with all endogenous and exogenous promoters and inhibitors, is so varied that it is clear that with different genotypes the results can be different (Eriksson et al 1967).

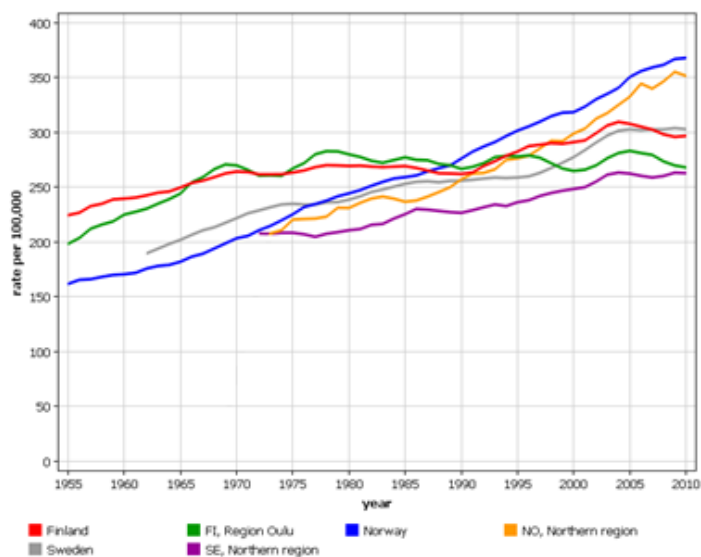
The external circumstances based on the culture and customs of a population modify the evolving a cancer. The culture, living place and living circumstances of the Skolt Sami have differed from those of other Sami and non-Sami. The history of Inari Sami and North Sami is also different. Inari Sami have settled down to one place around the Inari Lake as long ago as is known, and North Sami have been the most nomadic and migrated around the northern parts of Sweden, Norway, Finland until the borders were closed in the middle of the 19th century. Because of that, generalizing and referring to Finnish Sami as one group may be misleading, and an aberration or pathology of one group can become covered by the total results. From the statistical point of view, there are problems with small numbers and statistically insignificant SIRs which, however, can suggest hypotheses for further studies.

Low SIRs for all cancers have also been found among the Sami in other Nordic countries (Wiklund et al 1990, Hassler et al 2001, Hassler et al 2008, Haldorsen 2005, Norum 2011). The SIRs among the Sami in all Nordic countries are lower among Sami men than among the Sami women, contrary to what it is generally known from elsewhere (GLOBOCAN 2012).

The incidences of the reference populations have some influence on the standardized incidence ratios (SIRs), and therefore it should be noticed when comparing the results of different populations with different standard populations. In Figure 31, the time trends of incidences of the all site cancers of all reference populations of Studies II and III are presented. The incidence of the Hospital District of Lapland is missing, but it is running close below the corresponding graph of the Oulu district. The highest incidences among men and women are in Norway and its northern parts. From that follows that the SIRs of the Norwegian Sami were low (Study III, Table II). The newest study of Norwegian Sami has shown that until 2008, the cancer incidence has been statistically significantly low; the SIR for men is 0.88 (0.81–0.96) and women 0.90 (0.82–0.98) (Norum et al 2011).

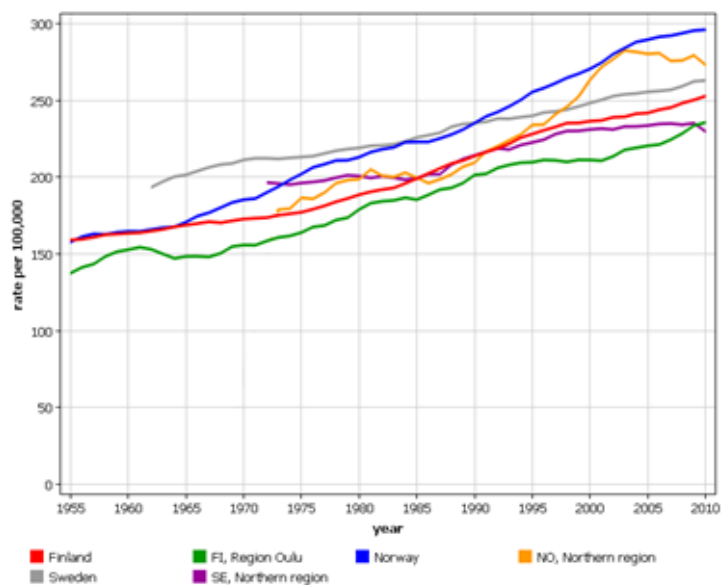
Since 1972, the incidence of men's cancer of all sites in northern Sweden (SE Northern region) is running lowest (Figure 31 A). It means that the incidence of Swedish Sami men in the North, really have low incidence of all sites cancer (Study III, Table II).

All sites
Incidence: ASR (World), Male age 0-85+



NORDCAN © Association of the Nordic Cancer Registries (28.4.2015)

All sites
Incidence: ASR (World), Female age 0-85+



NORDCAN © Association of the Nordic Cancer Registries (28.4.2015)

Figure 31. The age standardized (world) time trends of all site cancer incidences of the reference populations: Finland (FI), Sweden (SE) and Norway (NO) and their northern regions. All ages, 5-year smoothing. Upper: Men, lower Women (NORDCAN).

Cancer incidence, like mortality, among other Arctic Native populations has changed during recent decades. Several cancers of the native populations have a higher cancer incidence than the incidence of the main population in their countries (Friborg et al 2004). Among the Inuits in Alaska, Greenland and Canada, cancer was not particularly common in earlier decades (Hildes et al 1984), between the years 1969–1973 and 1999–2003, the all-site combined incidence rate increased by 35% among Inuit men and by 44% among Inuit women (Young et al 2008).

6.3.2 CANCER OF DIGESTIVE SYSTEM

Stomach cancer

Traditionally, the notion is held among the Inari people that stomach cancer is common in Inari and especially among Skolt Sami. The mortality of stomach cancer in Inari was statistically significantly increased during 1966–2010 (Finnish Cancer registry 2013). It is understandable that people think that the cause is radioactivity. The whole body measurements were done in the area several times (Rahola et al 1988), and many knew their count of radioactivity. Stomach cancer is not generally regarded as radiation cancer, although the radioactive food goes through stomach. However, a significant linear dose-response relationship has been found in the risk of stomach cancer among long-term survivors of cervical cancer treated by radiotherapy (Kleinerman et al 2013).

The radioactivity of the food in the Arctic has been discussed, but closer studies calculating the body burden doses and comparing them to the cancer statistics have found no unequivocal evidence of any excess of stomach or other radioactivity-induced cancers (cancers of thyroid, breast, oesophagus, colon, liver, lung, trachea, bladder, uretra, ureter, brain and nervous system, ovary, bone, non-melanoma cancer of the skin, leukemia or basal cell carcinoma of the skin) among the Finnish Arctic or the Sami population or the population of Alaska (Stutzman et al 1986, Lanier et al 1985, Kurtio et al 2010).

In the present study, mortality from stomach cancer among all Sami combined, was not different from that among the main population. The risk of stomach cancer among the North Sami and Inari Sami has been low since 1979 (the starting time of this study). Inari Sami had no cases at all in 1979–1998. On the contrary, mortality from stomach cancer among the Skolt Sami has been significantly high. Stomach cancer of Skolt Sami has begun to diminish last, later than that of Inari total population. Therefore, it could be fit to epidemiological transition, which is going on among all populations, but because of only a few cases, it is just a postulation (Omran 1971).

Stomach cancer among Swedish Sami has increased significantly (Wiklund et al 1990, Hassler et al 2008), but not among Finnish Sami in this study and Norwegian

Sami (Haldorsen et al 2005). The incidence of stomach cancer in Sweden is lower than in Finland and Norway. It increases the SIRs of Swedish Sami (NORDCAN 2014). The incidence of stomach cancer in the study of Kurttio et al (2010) among the Finnish Sami was slightly increased SIR 1.42 (0.65–2.68), as it was among the total population of Inari.

Stomach cancer has been and still remains one of the most common causes of cancer-related death and continues to be a major public health issue, in spite of decreasing trends in its incidence and mortality (Jemal et al 2011). 80–90% of stomach cancers develop in a sporadic setting, while the remaining 10% to 20% show a familial cluster, and approximately 1–3% have a clear inherited genetic susceptibility (Corso et al 2013).

Several environmental exposures have already been identified as risk factors for stomach cancer, including diet, smoking, bacterial infections and occupational exposures. The close association of *Helicobacter pylori* with peptic ulcers and stomach cancer has been documented in numerous studies (Rautelin et al 2004, Saghier et al 2013). *Helicobacter pylori* antibodies (IgG and IgA) were studied in 84 Sami and 80 non-Sami reindeer herders, but no significant difference was found (Laurila et al 1997). In that study the samples of the Sami were analysed as one group. Gastric cancer is increased only in the group of Skolt Sami, and its incidence among Inari Sami and Northern Sami is very low.

Excessive intake of salt and low intake of fresh fruits and vegetables are risk factors (Hirayama 1990, Fuchs et al 1995) for stomach cancer. Skolt Sami did not have fresh fruits. Before the “refrigerator-time” and even thereafter, they often ate air-dehydrated, salted and fermented sour fish. Dietary nitrosamines in fermented meat have been associated with stomach cancer in Swedish women (Larsson et al 2006). Nitrosamines in fish might have the same kind of influence. On the other hand, eating fish has been a cancer-lowering factor (Kolahdoots et al 2010). A deficiency of riboflavin among Skolts was notable (Hasunen et al 1975), and also a low concentration of glutathione reductase, measured from red cells and needed in antioxidant processes (Eriksson et al 1967), might be a part in the genesis of the cancer. To prevent the multi-step process of the mucosal damage in developing stomach cancer, regeneration by the antioxidants is needed. Smoking and alcohol consumption are also factors in the development of stomach cancer.

In conclusion, a one-sided diet and poverty have been the likely factors underlying the high incidence of stomach cancer among the Skolt Sami. During recent decades, the Skolts have had excellent public health nurses who have taught them to eat more berries, mushrooms, blood, liver and inner organs of animals (Jaana Isensee 2001, Leena Semenoja 2001). The rising living standard also has had its influence on the life of Skolt Sami, and their diet has become versatile and better for health.

Among Inuits in Greenland, Alaska and Canada, the occurrence of stomach cancer has declined, but among Inuits in Canada Nunangat with a population of

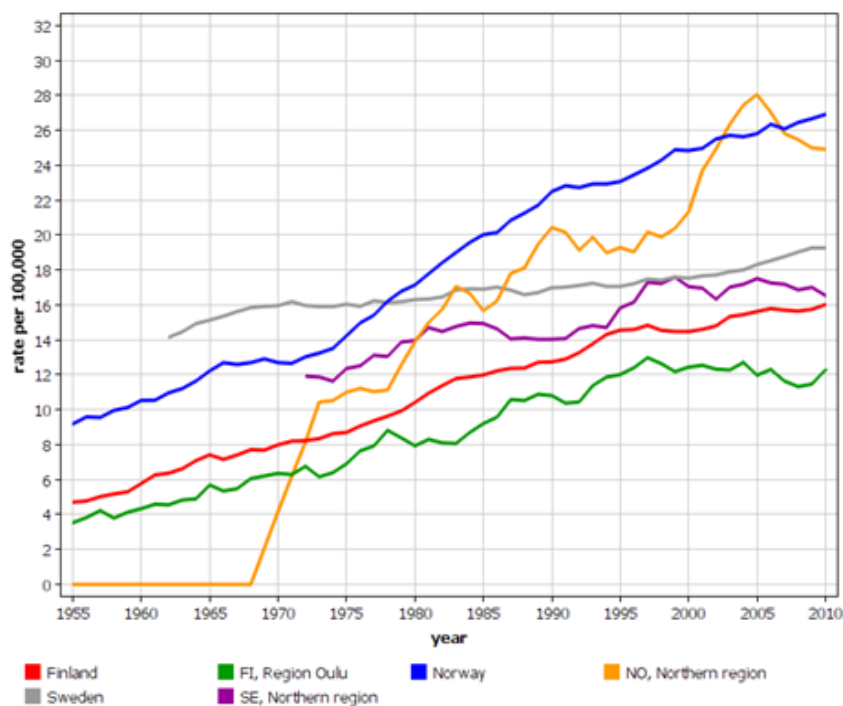
48,000, from which 82% are Inuits, the SIR is still 1.62 (1.02–2.56) among men and 1.46 (0.72–2.96) among women (Carrière et al 2012).

Cancer of the Colon

Cancer of the colon is a disease of economically developed populations but its incidence and mortality are rising in areas where the risk was formerly low (Tomatis 1990). The incidence of colon cancer among Finnish Sami did not differ from that of the general population in Finland.

In Study III, the SIR for colon cancer was significantly low among Swedish Sami men and Norwegian Sami men and women (Study III, Table II). The SIRs of Finnish Sami men and women were the highest (but insignificantly) because the reference population was the Hospital district of Lapland, in which the incidence is lower than the incidence of the Oulu Hospital district (FI Region Oulu) and a little less than it was in the whole of Finland. The NORDCAN graphics in Figure 32 A and B show that the incidence of colon cancer among Finnish men and women in northern Finland is the lowest when compared to the corresponding graphs of Norway and Sweden. The incidence curve of women in northern Sweden is rather close to the respective curve in Oulu Region, but the incidences among Norwegian men and women are by far the highest since 1980.

Colon Incidence: ASR (World), Male age 0-85+



NORDCAN © Association of the Nordic Cancer Registries (8.4.2015)

Figure 32 A. The time trends of the age standardized incidences (world) of the male reference populations of the colon cancer. Finland (FI), Sweden (SE) and Norway (NO) and their northern regions. All ages, smoothing 5 years. The follow up of the incidences of colon cancer have started in northern regions of Sweden and Norway about in the beginning of 1970s (NORDCAN 2015).

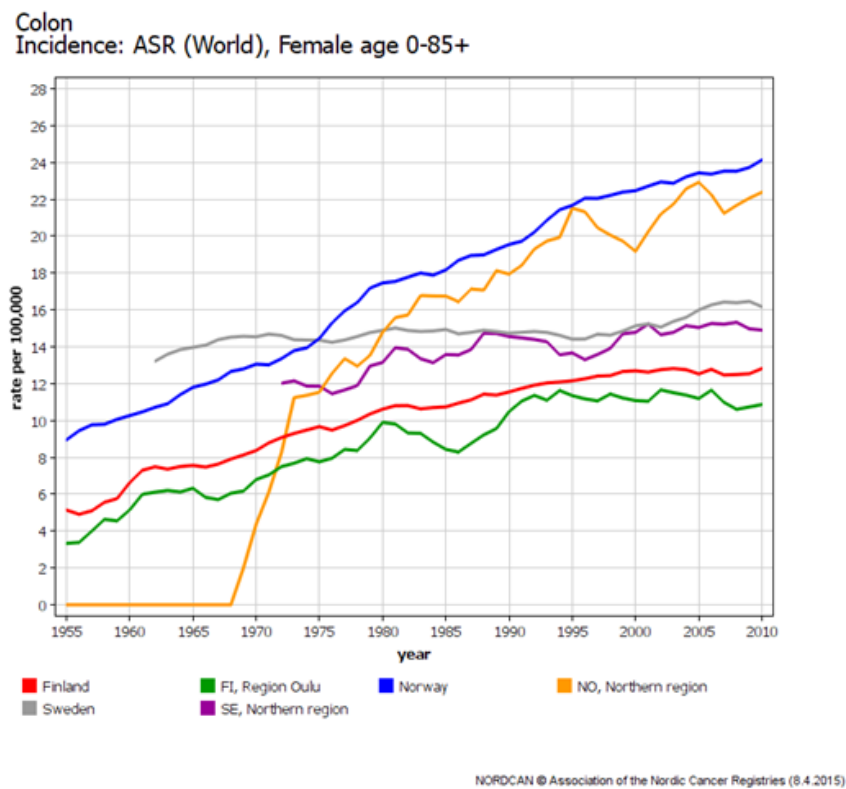


Figure 32 B. The time trends of the age standardized incidences (world) of the female reference populations of the colon cancer. Finland (FI), Sweden (SE) and Norway (NO) and their northern regions. All ages, smoothing 5 years. The follow up of the incidences of colon cancer have started in northern regions of Sweden and Norway about in the beginning of 1970s (NORDCAN 2015).

Consequently, the SIRs for Finnish Sami are relatively higher than the corresponding values of Sweden and Norway. Also, the time periods of the studies varied. The Swedish study was conducted in 1961–2003, the Norwegian study in 1970–1999 and Finnish study in 1979–2005. Figure 32 also shows that during the last 20 years the incidence curves of colon cancer diverged across the countries. However, the differences in SIRs for colon cancer of the Sami across countries are not very large considering the different reference populations.

Diet is by far the most important exogenous factor identified so far in the etiology of the cancers of colon and rectum. Thus, saturated fat and the lack of fibre in the diet increase the risk, and also the lack of exercise has been suggested as a factor. The traditional Sami food should be protective for colon cancer.

Much research has been done on the common variation and expression of

vitamin D-related genes and their relationships to cancer. There is strong evidence for a protective effect of vitamin D and colorectal cancer (Freedman et al 2007, Shui et al 2014, Cuzick 2014, Ordoñez et al 2014). That is in line with the high concentration of vitamin D in the food of Sami men who eat a lot of fish (Jokelainen 1965) and their low incidence of colon cancer, and also with the low vitamin D in the food of Sami women (Soininen et al 2002) and the slightly elevated incidence of colon cancer among them.

Early detection of colon cancer is difficult, because the symptoms are often unclear or there are no symptoms at all. Methods to detect cancer at an early stage have been discussed (Tomatis 1990). The SMR for colon cancer among Sami men and women was low, but that of non-Sami women was the same as that of Finnish women.

The SIR for colon cancer in 1971–2005 among the Finnish Arctic population (born in Sami municipalities) was 0.84 (0.68–1.00). The reference population was the population of Oulu Hospital Region with low incidence (Kurtio et al 2010). Colon cancer belongs to the cancers of high living standard and is predicted to increase along with advancing epidemiologic transition (Omran 1971).

Cancers of pancreas and liver and other digestive organs

The incidence or mortality for the liver and pancreatic cancer of Finnish Sami is not different from that in the main population. The observation was similar regarding the incidence of pancreatic cancer of Swedish and Norwegian Sami (Hassler et al 2008, Haldorsen et al 2005)

Early diagnostic difficulties exist regarding cancers of the pancreas and liver, and hence both are at a very advanced stage when found. The 5-year survival is 3–7% (Finnish Cancer Registry 2014). The risk factors for pancreatic cancer include tobacco in all forms, diabetes, obesity, chronic pancreatitis, some chemicals (e.g. nitrosoamines), sometimes family history and certain hereditary syndromes. None of the latter factors, except smoking, are prevalent among the Sami. In Greenland the incidence of pancreatic cancer is higher than in Denmark, SIR 2.38 (1.97–2.86), but the prevalence smoking is also high (60% of the population over 15 years) (Kirkegaard 2012).

The risk factors of hepatocellular cancers are chronic infections such as hepatitis B and C, which cause cirrhosis of the liver (El-Serag 2012, McMahon 2003). Among other arctic indigenous populations, hepatitis B is endemic, and hence liver cancer is also common, especially in Alaska, before vaccination against the hepatitis B was taken to use (Storm et al 1996).

6.3.3 LUNG CANCER

The main cause of lung cancer is smoking. Lung cancer was previously rare among all native groups in the arctic (Hildes et al 1984, Wiklund et al 1990). Among Sami in Norway, it is still relatively uncommon (Haldorsen et al 2005, Norum et al 2011). The Swedish Sami also have a relatively low lung cancer incidence (Hassler et al 2008). Among the Finnish Sami, the incidence of lung cancer is similar to that among the general population. In the health study of Finnish reindeer herders, there was no difference in the prevalence of smoking between Sami and non-Sami (Näyhä et al 1993). The public health nurse of Sevettijärvi told the author that Skolt Sami men are heavy smokers, and they start immediately after school. Women do not smoke. (Leena Semenoja, personal communication in 2001). The SIR for lung cancer among the Skolt Sami was high, but the difference from the reference population did not reach statistical significance. The corresponding SIRs of the North Sami and Inari Sami did not deviate from the reference level with any certainty. The common SIR for the other tobacco related cancers (larynx, oral cavity, pharynx, pancreas, oesophagus, kidney and bladder) among all Sami in Finland were roughly on the level of the general population (Dreyer et al 1997). The 5- year survival of lung cancer is low in Finland, also among the Sami population. The mortality of lung cancer among Sami does not differ from that among the main population.

Between the periods 1969–73 and 1999–2003, there was a substantial increase in lung cancer mortality among men (136%) and women (by 344%) among Circumpolar Inuits, notably in Canada (Young et al 2008). This is no wonder, because the Inuit women, men and children alike are heavy cigarette smokers (Foggin et al 1989). The SIR for pulmonary cancer in the Inuit area of Nunangat is 2.23 (1.90–2.61) among men and 3.70 (1.17–1.42) among women, compared with the rest of Canada (Carriere et al 2012). Among Inuits in Greenland, lung cancer is also relatively more common among women (SIR 2.1 (1.7–2.5)) than men (SIR 1.6 (1.3–1.8)) The incidences of Greenland are compared to the cancer incidence of Denmark (Friborg et al 2003). Lung cancer among women in Denmark is about 3 times more common than in Finland (NORDCAN graphics 2014). Hence, the SIRs of Inuits in Greenland are very high. Lung cancer among Inuits was first restricted to elderly women, who used the open flame lamps burning seal or fish oil. The partially burned residues of these oils are regarded as carcinogenic. At post-mortem examination Hildes et al (1984) observed heavy black pigmentation of the lungs exclusively in elderly Inuit women.

6.3.4 BREAST CANCER

Breast cancer is the most common cancer of women in the western world, and the incidence has been increasing, also in Finland. Fortunately, the mortality from

breast cancer has not increased, but rather it has decreased in recent years (Finnish Cancer Registry 2014). In the Arctic, breast cancer has been very rare. The risk of breast cancer among Finnish Sami is low among all subgroups and also among non-Sami and the entire population of Inari-Utsjoki. It is significantly low in all groups, except the group of the Skolt Sami, which is small, and the estimate is therefore inaccurate 0.42 (0.09–1.22) .

In the study of Wiklund et al (1990), the SIR for breast cancer among Swedish Sami was 0.37 (0.12–0.85), compared with the entire Swedish population, but the risk increased thereafter and actually reached the reference level when the study was extended to the year 2003 (Hassler et al, 2008). The SIR for breast cancer among Norwegian Sami in 1970–1997 was 0.85 (0.71–1.01) and 0.82 (0.76–0.90) in 1999–2008. The reference group was the non-Sami population of three northern counties of Norway (Norum et al 2011). The Finnish Sami have the lowest risk of breast cancer in Study III and Swedish non-reindeer herders the highest (Hassler et al 2008). This suggests that the non-reindeer herding Sami have changed their living habits more than women in the Swedish main population. Factors known to increase breast cancer risk are early menarche and late menopause (lifelong exposure to oestrogen, also oestrogen medications), genetic inheritance in mutations BRCA-1 and BRCA-2 genes and other genetic polymorphisms relevant to breast cancer risk, obesity after menopause (production of oestrogen and adipokines such as leptin and IGF-I) and high intake of fat, alcohol and to a lesser extent, smoking (Fredslund et al 2012), lack of physical activity and ionizing radiation (Brody et al 2003).

Those women who have given birth to at least 5 children have a 40% lower risk for breast cancer, ovarian cancer and cancer of the uterine corpus (Hinkula 2006). The birth rate in Inari (Sami and non-Sami) was lower than that of Finland until the 1940s, but thereafter, it has been higher in many years (Table 1). In Sami families, the average number of children was 5.9 in 1920–1970. Only 12.7% of Sami families are childless compared with the corresponding percentage of 24.4 % for the whole Finland (Karjalainen et al 1979). The average number of Sami children in Sweden was 5.3 in 1920–1958 (Mellbin 1962). Thus, the number of children in Sami families has been lower than in non-Sami families but still high enough to keep the incidence of breast cancer low.

When Schaefer et al (1974) studied the patient records from hospitals in the Canadian Arctic in North West Territories in 1950–1974, they found only two cases of breast cancer out of a total of 164 cancer cases. The custom of Inuits was to breast feed their children until the next child was born, usually 3½ years. That could protect them from breast cancer. Those two cases with invasive breast cancer had a history of 10 and 6 births, but they had not breastfed more than one and three months, respectively, with that breast which was later affected. Apparently, breast-feeding has been an important factor that has protected indigenous women from

breast cancer. The breast feeding time has traditionally been long among Sami, from half a year to 2–3 years (Leena Semenoja 2014).

Today, more than 500 chemicals have been found to be weakly estrogenic, including many chemicals in common use, such as constituents of detergents, pesticides and plastics. Those compounds mimic oestrogens in breast tissue and therefore may be linked with the risk of breast cancer. During breast-feeding they are transported to milk, and thus the amount of harmful, possibly carcinogenic substances is decreased (Falck et al 1992, Mussalo-Rauhamaa et al 1993, Brody et al 2003). Environmental pollutants have aroused concern because they could possibly increase the risk of breast cancer, especially among Inuits, because they eat the end products of marine food chains, where several cancer-inducing fat soluble compounds are enriched. In 1990 Mussalo-Rauhamaa et al (1991) found that the concentrations of beta-cyclohexane (HCH) were higher among breast cancer patients than among healthy controls of the same age. There are also other studies where the concentrations of different pollutants in the serum of breast cancer patients have been increased when compared to healthy women (Fredslund et al 2012, Negri et al 2003, Snedeker 2001). The relationship of contaminant exposure and depressed immunity has also been studied (Gilman et al 2009). The mechanism of how the hormones and pollutants accumulating to the breast tissue would generate cancer is under investigation (Brody et al 2003). Thus, breast feeding is an excellent way to decrease the risk of breast cancer (Collaborative group on hormonal factors in breast cancer 2002), possibly because lactation removes toxicants from the breast tissue along the fat in milk. The latter study group has estimated that breast feeding as long as in developing countries could reduce the risk of breast cancer by two-thirds.

In spite of the fear of environmental pollutants and radioactivity, the environment in Lapland seems to be cleaner than in big towns. Also, the Sami people are no longer at the end of any food chain where toxic substances are enriched. On the contrary, the incidence of breast cancer among Inuits has been increasing for several decades. In Alaska, for example, it was 25/100,000/personyears (py) in 1969–1973 and 79/100,000/py in 1989–2003. The corresponding increases in Greenland and Canada were from 36 to 38 and 14 to 38/100,000/py, respectively (Miller et al 1996, Young et al 2008). The discussion of benefits and disadvantages of breast feeding is going on among Inuits and researchers (AMAP Assessment 2009).

6.3.5 CANCER OF THE OVARY

The SIR for ovarian cancer was slightly elevated among Northern and Inari Sami, while among the Skolt Sami there were no cases at all. Among the non-Sami population in the same area, the SIR for ovarian cancer was significantly high.

Among the Swedish non-reindeer herding Sami, the excess incidence was also significant (SIR 1.58 (95%CI 1.22–2.05)). The incidence of ovarian cancer among Norwegian Sami was lower than among the standard population, but the deficit did not reach statistical significance.

Cancer of the ovary is difficult to diagnose early enough, and hence not much can be done after diagnosis. In Finland, the incidence of ovarian cancer since 1959 has been in the region of 9–11/100,000/year. The cause of this cancer is not known, but some risk factors have been identified. Thus nulliparity, infertility, late primiparity, late age at menopause are associated with an increased risk ([McGowan et al 1988](#)). In turn, multiparity, hysterectomy, female sterilisation and oral contraceptive use are associated with a reduced risk of ovarian cancer ([Booth et al 1989](#)).

Hereditary breast and ovarian cancer syndrome (HBOC), caused by a germ line mutation in tumour suppressor genes BRCA1 or BRCA2, is characterized by an increased risk for breast cancer, ovarian cancer, prostate cancer, and pancreatic cancer. The lifetime risk for ovarian cancer among individuals with a mutation in BRCA1 or BRCA2 is estimated at 11–40% ([Petrucci et al 2013](#)).

Today there is evidence that lifetime vitamin D exposure may decrease the risk of ovarian carcinoma ([Luriel et al 2011](#), [Toriola et al 2010](#), [Toriola 2011](#)). The daily intake of vitamin D was calculated in 21 Sami and 125 non-Sami pregnant women in the North of Finnish Lapland by using food diary and the frequency method ([Soininen et al 2002](#)). The estimated intake of vitamin D in both groups was 3.8 micrograms per day, while the recommended intake is 10µg per day ([Hasunen et al 2004](#), [THL 2014 Fineli](#)) during pregnancy. Thus, the low intake of vitamin D could be one reason for the high incidence of ovarian cancer among Sami and non-Sami in Inari-Utsjoki.

6.3.6 CANCER OF PROSTATE

Prostatic cancer is the most common cancer among men in the Western hemisphere, and the incidence is increasing worldwide. It is in the first place in Finland; the incidence was 85.6/100,000/year in 2011. However, among Finnish Sami, Swedish reindeer breeding Sami ([Wiklund 1990](#), [Hassler 2008](#), [Haldorsen 2005](#)), and Inuits ([Prener et al 1996](#), [Friborg et al 2004](#)) the incidence of prostate cancer is remarkably lower than among the respective national populations.

The known risk factors are age, black race, positive family history, vasectomy, and dietary fat intake, ([Pienta et al 1993](#)). Infections are suspected, too, and it appears that prostate cancer results from an inter play between endogenous hormones and environmental influences that include, most prominently, dietary fat, especially animal fat ([Key 1995](#)).

There is also evidence that vitamin D (or its metabolite 1,25(OH)₂D) has antitumor activity in prostate cells (Peehl 2003, Giovannucci 2005). The amount of vitamin D from the sun is low in northern latitudes, but consumption of fish is high. Sami men are used to eating a lot of fish. The content of vitamin D in the fish eaten by Sami is 13–25 µg/100g, while the recommendation is 10 µg /day.

Old men often have clinically inconsequential malign cells in their prostate. Suen et al (1974) found hidden prostatic cancers in 66% of obductions conducted on men over 65 years of age. This may apply to Sami men as well, but the rarity of prostatic cancer among them (SIR 0.30 (0.18–0.54)) may be also due to other reasons. The incidence of non-Sami is similar to the remainder of Finnish population and the mortality is significantly higher, SIR 1.59 (95% CI 1.01–2.38). The mortality of prostate cancer of Sami men is significantly low. This may reflect the fact that diagnostic procedures are readily available in the Sami area, and the low risk of prostate cancer among Sami is likely to be due to differences in the prevalence of risk factors and perhaps, to genetic factors.

6.3.7 CANCER OF UTERINE CERVIX

In this study, the SIR for cancer of the uterine cervix among Sami was slightly increased. All cases were located outside the regular mass screenings, because they were older than 60 years which is the age limit in these screenings. The incidence of this cancer in Finland has remained low because of the mass screenings, which started in the 1960s.

The situation is quite different in countries where no regular mass screenings were conducted. Cancer of the uterine cervix was a special problem in Greenland (Sander et al 2014). The incidence was low in the 1950s (10/100,000), higher in the 1960s (30/100,000) and still higher in the 1980s (60/100,000). The screenings started in 1985, and the incidence has diminished since then. In Greenland, it is now 25/100,000, compared with the Finnish figure of 4/100,000.

Major risk factors are related to sexual habits and the sexually-transmitted human papilloma virus. There are good experiences of Pap smear screening in Finland to detect early stages of cervical cancer. Vaccination against cervical cancer is also used nowadays. Cervical cancer is also common in other parts of the Inuit and Chukchi area. In Chukotka, it is in the third place of the cancer mortality of women. Areas in the circumpolar region that implement vaccination include Alaska, Canada, Russia and Nordic countries. These countries and regions vary as far as infrastructure and support for vaccination are concerned, and whether the vaccine is included in the public programme (Dunne et al 2013).

6.3.8 OTHER CANCERS

The SIR for the group of “other digestive organs” is high among Sami and non-Sami. It is difficult to interpret, because the group comprises several different cancers.

6.3.9 SPECIAL CANCERS

While the Inuits in Greenland, Alaska and Canada have an especially high incidence of salivary and nasopharyngeal cancers, no cancer is typical of the Sami. The aetiology of cancers typical of the Inuits is thought to be infectious (Ebstein-Barr virus) or based on the consumption of salted fish in childhood or genetic disposition (Lanier et al 1996).

There were only 2 cases of pharyngeal cancer among Finnish Sami men, while the SIR was 2.40 (0.29–8.66). The most probable cause in these cases is tobacco. There were no cases of salivary or pharyngeal cancers among Sami women.

6.3.10 COMPARISON OF THE CANCER INCIDENCES AMONG SAMI AND AMONG GENERAL POPULATIONS OF FINLAND, SWEDEN AND NORWAY

When the incidences of the all sites- cancer was calculated for Finnish, Swedish and Norwegian Sami and compared with those of the general populations of each country, it was clearly seen that the incidences were lower among Sami, except the incidence among Swedish Sami women, whose cancer incidence was on the same level as that of the general populations (Study III, Figure II).

6.4 SURVIVAL OF SAMI CANCER PATIENTS (STUDY IV)

The cancer-specific survival experience of patients classified as Sami and non-Sami was compared with that of the Finns outside the cohort. The 5-year cancer specific survival was estimated only for all cancers combined because of the small numbers of individual cancers. The different Sami groups could only be assessed together due to the small numbers of cancer cases in each of them; hence the possible survival differences between the Sami categories could not be assessed. The starting assumption of this study was that both genetic or lifestyle features of the Sami, and long distances to hospitals for medical care could have a decreasing influence on the survival of cancer. The results, however, do not support these hypotheses.

Norum et al (2011) have compared the cancer survival in 8 municipalities included in the administration area of the Sami language law in Norway of the

cancers diagnosed in 1999–2003 to the survival of cancer patients in 11 other municipalities. The 5-year survival was similar among Sami speaking municipalities and the control group.

Cancer-specific survival ratios of patients of 6 major racial or ethnic groups from the USA were described during the years 1975–1997 in the USA (Clegg et al 2002). In 1975–1987, the 5-year cancer survival of American Indian and Alaskan Native patients was the lowest; 25% in males and 36% in females. The respective survival per cents for the non-Hispanic Whites were 35% and 46%. Although the 5-year survival of cancer patients during 1988–1997 in any group was more favourable than in 1975–1987, the differences between ethnic groups persisted.

The 5-year survival for Alaska Natives was 40% for males in 1988–1997 and 47% for females. An 11 percent unit lower all-site cancer survival ratio was reported in a comparison between the Alaska Natives and the USA Caucasian cancer patients in 1984–1994 (Lanier et al 2001).

The above difference resulted from survival rates of various cancers having higher or lower survival rates. Among Alaska Natives, the five year cancer survival rates were lower for cancers of the oral cavity and pharynx, nasopharynx and lung (lower by 20%, 26% and 5%, respectively), but higher for cancers of liver and uterus with excesses of 36% and 14% respectively.

The survival curves of Sami cancer patients and their controls – matched according to sex, age and cancer type - were on a slightly lower level than the respective curves for the non-Sami and their controls (Study IV, Figure 1). The reason for this difference is the different cancer type distribution of the Sami and non-Sami. The Sami have a lower incidence of cancers with high survival (cancers of the skin, breast, prostate, testis, kidney, bladder and thyroid, and Hodgkin lymphoma) than the non-Sami, while the incidence of more lethal common cancer types such as stomach cancer or lung cancer is not lower (Study II). The Sami persons were also older than the non-Sami, and older cancer patients tend to have lower relative survival rates than young ones. There was no difference between those cancers the Sami have, compared with the general population, and the same is true for the non-Sami population.

There is no data on the survival of Sami cancer patients before 1979. However, the cancer mortality/incidence ratios in the of northernmost Finland in the 1950s suggest that the survival of cancer patients in that area was worse than in the rest of Finland, but the difference disappeared before the 1970s, thanks to a more rapid decrease in the mortality/incidence ratio in the North (Pukkala et al 2010). It is likely that the survival of patients with cancer (and other diseases) improves when the living standard increases and the living conditions improve. They are rather good today in Finnish Lapland. The living circumstances of Indians and Alaskan natives are quite different from those of the Sami in Finland.

The explanation for the similar cancer survival of Sami and non-Sami and the Finnish population might be the similar possibilities to get physician consultations and care everywhere in Finland. When the sickness insurance act came into force in 1964 (364/1963), it recognized the need for travelling to the medical doctor. From that time on, it was possible to get reimbursement for travelling costs. When the Public Health Act came into force in 1972 (66/1972), it was a big step towards better health care, especially in the sparsely populated rural areas. The municipalities got more medical doctors and better buildings and equipment

7 CONCLUSIONS

In the 1960s and 1970s, common views were expressed that the radioactive fallout in northern Fennoscandia may have induced cancer and increased mortality (Miettinen et al 1961, Miettinen 1965). The present study based on mortality and cancer incidence of the Sami during the period 1979 - 2010 provides no support for this assumption. The overall observation was that the Sami health is in transition towards the standard of the main population, but the Sami subgroups and also genders may be at different stages of transition. The assumption that cancer incidence and mortality would be higher among the Sami than in the Finnish general population, could not be verified, except for some individual cancers that showed relatively high rates. No radiation-induced cancer type in particular stood out among the Sami. Mortality from individual diseases varied between the Sami living in different Nordic countries and sometimes between the subgroups of the Finnish Sami. Some of the variation could be explained by living habits typical of the Sami, and inherited features may also play a role. Generally speaking, the way of life of the Sami seems to have had favourable influence to their health, but today, they are facing new risks associated with modern living habits, the results of which are only partly visible yet.

The answers to the study questions are shown below:

(1) Do the total and cause specific mortality among the Sami differ from those among the non-Sami in same area and that among the general population of Finland? Are there differences in the cause specific mortality between the North Sami, Inari Sami and Skolt Sami?

The total mortality among the Sami did not differ from that among the non-Sami living in the same area or from that among the general population of Finland, but differences were found in the detailed cause of death pattern. The disease mortality and mortality from malignant neoplasms among Sami men were significantly lower than the disease mortality in Finland in general and also significantly lower than that of the non-Sami in the same area. The disease mortality among the Sami women did not differ from the disease mortality or total mortality among the non-Sami. The study does not provide any support to the assumption that environmental pollution would be associated with an elevated mortality among the Sami.

Mortality from accidents and violence was significantly high among the Sami and non-Sami men compared with the general population of Finland. The Sami

men have a high risk of death from land traffic accidents, water transport accidents, drowning and suicide. However, mortality represents only “the tip of the iceberg”, and also non-fatal accidents and suicide attempts have likely caused a lot of suffering and disability, which together warrant preventive measures among this population.

The high number of suicides among the Sami points to a high prevalence of mental discomfort, which have a multitude reasons and a large impact on the well-being of the Sami and their families.

(2) Does the cancer incidence among the Sami differ from that among the non-Sami population in same area and that among the general population of Finland? Are there differences in cancer incidence between the North Sami, Inari Sami and Skolt Sami?

Cancer incidence among the Finnish Sami is significantly lower than that among the general population of Finland, but also the cancer incidence among non-Sami women is significantly lower than that of general population. The cancer incidence figures among the North Sami and Inari Sami subgroups are generally low. However, stomach cancer has been relatively common among the Skolt Sami. This can be interpreted in terms of delayed epidemiological transition among this isolated Sami group. The high incidence of lung cancer among Skolt Sami men could be attributed to the high prevalence of smoking among them. On the contrary, North and Inari Sami men showed a relatively low incidence of lung cancer. Significantly low incidence of prostatic cancer, skin basal cell carcinoma and cancers of bladder, ureter and uretra was found among the Sami men. A significantly low incidence of breast cancer and basal cell skin cancer was found among Sami women. Cancers of “other digestive organs” were significantly common among all Sami and non-Sami groups in the area. Ovarian cancer was relatively common among the Sami women except the Skolt Sami, but it was also common among the non-Sami women in the area. The results did not point to any association between radioactive pollution and cancer incidence in the Inari and Utsjoki area.

(3) Are mortality and incidence of cancer among the Finnish Sami similar to those among the Sami in Sweden and Norway?

The cancer mortality and incidence among the Sami men are parallel in Finland, Sweden and Norway relative to their main populations. In Finland and Norway, the standardized incidence ratio of all cancers combined among Sami women is significantly below the respective reference populations, but the Swedish Sami women seem to be the forerunners in epidemiological transition towards the western cancer incidences. Breast cancer, which is very low among Finnish Sami women, is

the same among Swedish Sami women as that of the general Swedish population. The SIR of the stomach cancer among Swedish Sami is significantly high when compared to that of the Swedish population. The SIR of stomach cancer among Finnish and Norwegian Sami did not differ from that of the corresponding general population

(4) Is the survival of the Sami cancer patients worse than the survival of cancer patients in all Finland?

This sub-study was conducted to answer the question whether the special living conditions in the Sami district, including long geographical distances, isolation and availability of health services had adversely influenced the survival of cancer patients. However, the survival of the Sami cancer patients did not differ from that of cancer patients in all Finland. The finding was similar regarding the non-Sami population in the area. Thus, no support was found to the assumption that local conditions would affect cancer survival. The result was attributed to the good accessibility and high quality of health services throughout the country, including the remote areas. In fact, the study period 1979–2010 was several years ago, and since that time the circumstances in health care in that area have changed.

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9 REFERENCES

- Ahlm K, Hassler S, Sjölander P, Eriksson A. Unnatural deaths in reindeer-herding Sami families in Sweden. *Int J Circumpolar Health* 2010; 69:129-37.
- AMAP 1998. Assessment Report 1998: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway 1998:1-8, 531-3, 553-63, 775-844. [Cited 20 Jan 2014]. Available at: <http://www.amap.no/documents/doc/amap-assessment-report-arctic-pollution-issues/68>
- AMAP 2002. Assessment 2002: Radioactivity in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. Pp. xi + 100. [Cited 20 Jan 2014]. Available at: <http://www.amap.no/documents/doc/amap-assessment-2002-radioactivity-in-the-arctic/93>
- AMAP 2006. Assessment 2006: Acidifying Pollutants, Arctic Haze, and Acidification in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway, 2006. Pp. xi+111. ISBN 82-7971-046-9. [Cited 20 Jan 2014]. Available at: <http://www.amap.no/documents/doc/amap-assessment-2006-acidifying-pollutants-arctic-haze-and-acidification-in-the-arctic/91>
- AMAP 2009. Assessment 2009: Human Health in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway 2009. Pp. xiv+254. ISBN 978-82-7971-051-6. [Cited 20 Jan 20th 2014] Available at: <http://www.amap.no/documents/doc/amap-assessment-2009-human-health-in-the-arctic/98>
- AMAP 2011. Arctic pollution 2011 (Mercury). [Cited 4 Sept 2013]. Available at: <http://www.amap.no/documents/doc/arctic-pollution-2011-mercury/89>
- Andersen KL, Lønying Y, Nelms JD, Wilson O, Fox RH, Bolstad A. Metabolic and thermal responses to a moderate cold exposure in nomadic Lapps. *J Appl Physiol* 1960;15:649-53.
- Andersen A-B, Ag G, Stenfors L-E. Occurrence of Otitis Media in an Arctic Region. *Acta Otolaryngol* (Stockh); Suppl 1997;529:11-3.
- Anttonen H, Virokannas H, Sorri M. Noise and hearing loss in reindeer herders. *Arct Med Res* 1994;53(Suppl 3):35-40.

- Aromaa A, Björkstén FB, Eriksson AW, Maatela J, Kirjarinta M, Fellman J, Tamminen M. Serum cholesterol and triglyceride concentrations of Finns and Finnish Lapps. I Basic data. *Acta Med Scand* 1975;198:13-22.
- Asp E. The Finnicization of the Lapps. A case of acculturation. *Ann Univ Turkusiensis. Series B*, 100. Turku University 1966. Forssa; 1966:21-6.
- Bang HO, Dyerberg. The bleeding tendency in Greenland Eskimos. *Dan Med Bull* 1980;27(4):202-5.
- Baxter J D. An overview of twenty years of observation concerning etiology, prevalence, and evolution of otitis media and hearing loss among the Inuit in the eastern Canadian arctic. In: Postl BD, Gilbert P, Goodwill J, Moffat MEK, O`Neil JD, Sarsfield PA, Young KT. (eds.). *Circumpolar Health 90. Proceeding of the 4th International Symposium on Circumpolar Health* Whitehorse, Yukon, May 20-25, 1990. *Arct Med Res Suppl* 5. ISSN 0787-5339. Univ Manitoba Press 1991:616-9.
- Baxter JD, Julien G, Tewfik TL, Ilecki HJ, Crago MB. Observations on the prevalence of the ear disease in the Inuit and Cree Indian school population of Kuujjuaraapik. *J Otolar* 1986;15(1):25-30.
- Beaudry PH. Pulmonary function survey of the Canadian Eastern Arctic Eskimo. *Arch Environ Health* 1968;17:524-8.
- Bennett PH, Burch TA, Miller M. Diabetes mellitus in American (Pima) Indians. *Lancet* 1971;11(7716):125-8.
- Berg A-M, Niemensivu H, Piha T, Puska P. Suomalaisen aikuisväestön terveystäyttyminen. Kevät 1989. Kansanterveyslaitos 1990; B1: Taulukko 29B. [Health behaviour among Finnish adult population. Spring 1989. Published by Finnish National Institute 1990. Table 29B]. Finnish.
- Berg S. Kartoitus poron organoklooripitoisuuksista. Ympäristö ja terveys. 1994;7-8:73-6. Finnish. [Organochlorine compounds in reindeer]. Finnish.
- Berry JW. Acculturation. *Arct Med Res* 1990;49:142-50.
- Bjartveit K, Forsdahl A, Hålldin E, Lehman E, Nordøi A, Stromme J, Try K, Westlund K. The Cardiovascular study in Finnmark 1974-75. *Arct Med Res Rep* 25. Oulu 1979. 191p. ISSN 0355-9823
- Bjerregaard P. Causes of death in Greenland 1968-1985. *Arct Med Res* 1988;47:105-23.
- Bjerregaard P, Dyerberg J. Mortality from ischaemic heart disease and cerebrovascular disease in Greenland. *Int J Epidemiol* 1988;17:514-9.
- Bjerregaard P. Fatal accidents in Greenland. *Arct Med Res* 1990;49:132-41.

- Bjerregaard P. Fatal non-intentional injuries in Greenland. *Arct Med Res* 1992;51:22-6.
- Bjerregaard P, Young TK, Hegele RA. Low incidence of cardiovascular disease among the Inuit - what is the evidence? *Atherosclerosis* 2003;166:351-7.
- Bjerregaard P, Young TK, Dewailly E, Ebbesson SO. Indigenous health in the Arctic: An overview of the circumpolar Inuit population. *Scand J Public Health* 2004;32:390-5.
- Bjerregaard P, Fjordside S, Hansen MG, Petrova MB. Dietary Selenium Reduces Retention of Methyl Mercury in Freshwater Fish. *Environ. Sci. Technol.* 2011;45(22):9793-8.
- Björkstén FB, Aromaa A, Eriksson AW, Maatela J, Kirjarinta M, Fellman J, Tamminen M. Serum cholesterol and triglyceride concentrations of Finns and Finnish Lapps. II Interpopulation comparisons and occurrence of hyperlipidemia. *Acta Med Scand* 1975;198:23-33.
- Booker JM, Hellekson CJ. Prevalence of seasonal affective-disorder in Alaska. *Am J Psych* 1992;149(9):1176-82.
- Booth M, Beral V, Smith P. Risk factors for ovarian cancer: a case -control study. *Br. J. Cancer* 1989;60:592-8.
- Borodulin K, Levälähti E, Saarikoski L, Lund L, Juolevi A, Grönholm M, Jula A, Laatikainen T, Männistö S, Peltonen M, Salomaa V, Sundvall J, Taimi M, Virtanen S, Vartiainen E. Kansallinen FINRISKI 2012-terveystutkimus. Raportti 22/2013. Page 19. In Finnish. ISBN 978-952-302-054-2 , ISSN 1798-0089 . Available at: <http://urn.fi/URN:ISBN:978-952-302-054-2>
- Brody JB, Rudel RA. Environmental pollutants and breast cancer. *Environ Health Perspect* 2003;111:1007-19.
- Brustad M, Parr CL, Melhus M, Lund E. Dietary patterns in the population living in the Sami core areas of Norway - the SAMINOR study. *Int J Circumpolar Health* 2008;67:84-98.
- Bubenik GA, Konturek SJ. Melatonin and ageing: Prospects for human treatment. *J of Physiol Pharmacol* 2011;62:13-9.
- Carrière GM, Tjepkema M, Pennok J, Goedhuis N. Cancer pattern in Inuit Nunangat:1998-2007. *Int J Circumpolar Health* 2012;71:18581- <http://dx.doi.org/10.3402/ijch.v71i10.18581> [Cited 9 Sept 2014].
- Cavalli-Sforza LL, Menozzi P, Piazza A. The history and geography of human genes. Princeton University Press 1994: 208-73.

- Chashin VP, Goon GE. Ecology and population health in the Russian Barents Region: Problems and priority areas of co-operation. Conference of Health ministers in the Barents Region in Bodø, Norway 11-13. April 1994.
- Chalam KV, Khetpal V, Rusovici R, Balaiya S. A review: role of ultraviolet radiation in age-related macular degeneration. *Eye Contact Lens* 2011;37(4):225-32. doi: 10.1097/ICL.0b013e31821fbd3e
- Clegg LX, Li FP, Hankey BF, Chu K, Edwards BK. Cancer survival among US whites and minorities. A SEER (Surveillance, Epidemiology and End Results) program population based study. *Arch Intern Med* 2002;162:1985-93.
- Collaborative group on hormonal factors in breast cancer. Breast cancer and breast feeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50 302 women with breast cancer and 96 973 women without the disease. *Lancet* 2002;360(9328):187-95.
- Corso G, Roncalli F, Marrelli D, Carneiro F, Roviello F. History, pathogenesis, and management of familial gastric cancer: original study of John XXIII's family. [Cited 13 Oct 2014]. Available at: *Biomed Res Int* 2013;385132, 2013. doi: 10.1155/2013/385132 PMID: 23484115.
- Crile GW, Quiring DP. Indian and Eskimo metabolisms. *J Nutr* 1939;18(4):361-8.
- Cox DR. Regression models and life table (with discussion). *J R Stat Soc B*. 1972;34:187-220.
- Czeisler CA, Duffy JF, Shanahan TL et al. Stability, precision, and near-24-hour period of the human circadian pacemaker. *Science*. 1999;284(5423):2177-81.
- De Fabo EC. Arctic stratospheric ozone depletion in increased UVB radiation: Potential impacts to human health. *Int J Circumpolar Health* 2005;64:509-22.
- Demographics of Greenland. [Cited 12 March 2014] Available at: http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Demographics_of_Greenland.html
- Derome J, Aarrestad PA, Aspholm P, Bakkestuen V, Bjerke J, Erikstad K, Gytarsky M, Hartikainen M, Isaeva L, Karaban R, Korotkov V, Kuzmicheva V, Lindgren M, Lindroos A-J, Myking T, Poikolainen J, Rautio P, Røsborg I, Salemaa M, Tømmervik H, Vassilieva N. Current state of terrestrial ecosystems in the joint Norwegian, Russian and Finnish border area. In: Current state of terrestrial ecosystems in the joint Norwegian, Russian and Finnish border area Project Ka 00 72

- Interreg III Kolarctic/ Final report development and implementation of an environmental monitoring and assessment programme in the joint Finnish, Norwegian and Russian border area, 2003-2006. [Cited 15 Feb 2013]. Available at: https://helda.helsinki.fi/bitstream/handle/10138/38274/15_Current_State_of_the_Terrestrial_Environment.pdf?sequence=1
- Dreyer L, Winther JF, Pukkala E, Andersen A. Tobacco smoking. In: Olsen JH, Andersen A, Dreyer L, Pukkala E, Tryggvadottir L et al. (eds.). Avoidable cancers in the Nordic countries. *APMIS* 1997;105(Suppl 76):9–47.
- Dreyer L, Winther JF, Andersen A, Pukkala E. Alcohol consumption. In: Olsen JH, Andersen A, Dreyer L, Pukkala E, Tryggvadottir L, Gerhardsson de Verdier M, Winther JF. (eds.). Avoidable cancers in the Nordic countries. *APMIS* 1997;105(Suppl 76):48–67.
- Dudarev AA, Chupakhin VS, Odland JØ. Cancer mortality in the indigenous population of coastal Chukotka 1961-1990. *Int J Circumpolar Health* 2013;72: [Cited 14 Feb 2014]. Available at: <http://www.circumpolarhealthjournal.net/index.php/ijch/article/view/20471>
- Dudarev AA, Chupakhin VS, Odland JO. Health and society in Chukotka: an overview Citation: *Int J Circumpolar Health* 2013, 72: 20469 - <http://dx.doi.org/10.3402/ijch.v72i0.20469>
- Dunne EF. HPV and HPV-Associated Diseases. *Infectious Disease Clinics of North America*, 2013;27(4):765-778.
- Ebeling K. Suomen saamelaisten tuberkuloosilantteen kehitys vuosina 1951-1968. *Duodecim* 1974;90:172-7.
- Edin-Liljegren A, Hassler S, Sjölander P, Daerga L. Risk factors for cardiovascular diseases among Swedish Sami - a controlled cohort study. In: Leppäluoto J. (ed.). *Circumpolar Health Supplement 2/2004. Proceedings of the 12th International Congress on Circumpolar Health. September 10-14, 2003 Nuuk, Greenland.* *Int J Circumpolar Health* 2004;63(Suppl 2):292-7.
- Ekvall S. On the history and conditions of the life of the West Bothnian nomad Lapps, their food and health conditions. *Acta Med Scand* 1940;105:329-59.
- Eliassen B-M, Graff-Iversen S, Melhus M, Løchen M-L, Broderstad AR. Ethnic difference in the prevalence of angina pectoris in Sami and non-Sami populations: the SAMINOR study. *Int J Circumpolar Health* 2014;73:21310 –Available at: <http://dx.doi.org/10.3402/ijch.v73.21310>

- El-Serag HB. Epidemiology of viral hepatitis and hepatocellular carcinoma. *Gastroenterology* 2012;142(6):1264-73.
- Eriksson AW, Fellman J, Forsius H, Gustafsson B, Lindström C, Kirjarinta L, Kirjarinta M, Lehmann W, Benöhr H, Waller HD. Red cell glutathione reductase deficiency among Skolt Lapps. *Bull Eur Gen* 1967;1:73-5.
- Eriksson AW. Population genetic studies on Finnish Lapps. In: Bylund E, Linderholm H, Rune O. (eds.). *Ecological problems of the circumpolar area. Papers from the International Symposium at Luleå, Sweden, June 28-30, 1971.* Norrbottens museum. Luleå 1974.
- Eriksson AW, Forsius H, Fellman J. Populationgenetiska undersökningar i Lappland. [Population genetic research in Lapland]. Finska Läkarsällskapets Handlingar 1975;119:15-30. Swedish.
- Eriksson AW, Lehmann W, Simpson NE. Genetic studies on circumpolar populations. In: Milan FA, (ed.). *The human biology of circumpolar populations. International Biological Programme 21.* Cambridge: Cambridge University Press; 1979:81-168. ISBN 0 521 22213 3.
- Eriksson AW. Anthropology and Health in Lapps. *Coll Antropol* 1988;12:197-235.
- Ervasti O, Virokannas H. Paleumat. In: Näyhä S, Hassi J. (eds.). *Poronhoitajien elintavat, työ ja terveys. Kansaneläkelaitoksen julkaisuja ML:27.* Helsinki 1993: Kelan omatarvepaino Helsinki; 1993:149-55. Finnish.
- EVIRA 2013 Finnish Food Safety Authority Evira. Elintarvikkeiden ja talousveden kemialliset vaarat. [The risks of the food and drinking water]. Finnish. *Eviran julkaisuja* 2/2013:15. ISBN 978-952-225-121-3. [Cited 13 Sept 2013]. Available at: <http://www.evira.fi/portal/fi/tietoa+evirasta/julkaisut/?a=view&productId=361> Finnish.
- EVIRA 2013 Finnish Food Safety Authority Evira. Recommendations for eating fish. [Cited 26 Nov 2013]. Available at: <http://www.evira.fi/portal/en/food/information+on+food/handling+and+storage/fish/>
- Falck F, Ricci A, Wolff MS, Godbold J, Deckers P. Pesticides and polychlorinated biphenyl residues in human breast lipids and their relation to breast cancer. *Archives of Environmental Health*. 1992;47(2):143-7.
- Feigin VL, Rinkel GJE, Carlene M, Lawes CMM, Bennett DA, van Gijn J, Anderson CS. Risk Factors for Subarachnoid Haemorrhage. An updated systematic review of epidemiological studies. *Stroke*. 2005; 36: 2773-80. Published online 2005, doi: 10.1161/01.STR.0000190838.02954.e8

- Finnish Cancer Registry 2012. The cancer mortality and incidence of the Sami municipalities Inari, Utsjoki and Enontekiö 1971-2010.
- Finnish Cancer Registry 2014. Cancer registration in Finland.
<http://www.cancer.fi/syoparekisteri/en/registration/>
- Finnish Cancer Registry 2014. Mass Screening Registry. [Cited 13 Feb 2014]
 Available at: <http://www.cancer.fi/syoparekisteri/en/mass-screening-registry/>
- Finnish Cancer Registry 2014. Survival ratios.
<http://www.cancer.fi/syoparekisteri/en/statistics/newest-survival-ratios/>
- Finnish Cancer Registry 2014. Institute for Statistical and Epidemiological Cancer Research. Age-adjusted incidence rates of cancer per 100,000 person-years in 1966-2012, by primary site and period. [Cited 18 Sept 2014]
<http://www.cancer.fi/syoparekisteri/en/statistics/cancer-statistics/>
<http://stats.cancerregistry.fi/stats/eng/veng0005io.html> <http://stats.cancerregistry.fi/stats/eng/veng0006io.html>
- Fogelholm R, Murros K. Cigarette smoking and subarachnoid haemorrhage: a population-based case-control study. *J Neurol Neurosurg Psychiatry* 1987;50:78-80. doi:10.1136/jnnp.50.1.78
- Foggin PM, Aurillon N. Respiratory health indicators and acculturation among the Inuit and Cree of northern Quebec: a regional approach using geographic seriation analysis. *Soc Sci Med* 1989;29:617-26.
- Forsdahl A. Living conditions in childhood and subsequent development of risk factors for arteriosclerotic heart disease. The cardiovascular survey in Finnmark 1974-75. *J Epidemiol Community Health*. 1978;32:34-7.
- Forsdahl A, Hålldin E, Lehmann E, Nordoy A, Stromme J, Try K, Westlund K. The Cardiovascular study in Finnmark 1974-75. *Nordic Council for Arct Med Res Rep* 25. Oulu 1979. ISSN 0355-9823.
- Forsdahl A. Helsetjeneste i Norsk-Finske grensestrøk. *Tidsskr Nor Laegeforen* 1981;7:449-52. [Health care on the Norwegian and Finnish border area]. Norwegian.
- Forsdahl A. [A physician from Finnmark who pointed out the significance of heredity in congenital hip dysplasia.] Norwegian. *Tidsskr Nor Laegeforen* 2000;120:2672-3. [Cited 16 Nov 2014] Available at: <http://tidsskriftet.no/article/175963/>
- Forsius H, Luukka H, Eriksson AW. Ophthalmogenetic studies on the Skolt Lapps. *Acta Ophthal* 1971;49:498-502.

- Forsius H. Pterygium, climatic keranopathy, and pinguecula of the eyes in arctic and subarctic populations. In: Circumpolar Health 1974. Schephard R J, Itoh S. (eds.). Proceedings of the 3rd International Symposium. Yelloknife, NWT. University of Toronto Press. Toronto 1976:425-32.
- Forsius H. Ophthalmology. In: Milan F. (ed.). The Human Biology of Circumpolar Populations. Cambridge University Press, Cambridge 1980:193-211.
- Fredslund SO, Bonefeld-Jørgensen EC. Breast cancer in the Arctic - changes over the past decades. *Int J Circumpolar Health* 2012;71:19155- <http://dx.doi.org/10.3402/ijch.v71i10.19155>.
- Freedman DM, Looker AC, Chang SC, Graubard BI. Prospective study of serum vitamin D and cancer mortality in the United States. *J Natl Cancer Inst* 2007;99(21):1594-602.
- Friborg J, Kock A, Wohlfarht J, Storm HH, Melbye M. Cancer in Greenlandic Inuit 1973-1997. In: Leppäluoto J. (ed.). Circumpolar Health 2003. Proceedings of the 12th International Congress on Circumpolar Health. Nuuk, Greenland. *Int J Circumpolar Health* 2004;63(Suppl 2):195-8.
- Fuchs CS, Mayer RJ. Gastric carcinoma. *N Engl J Med* 1995;333: 32-41.
- Gaudette LA, Freitag S, Dufour R, Baikie M, Gao R-N, Wideman M. Cancer in Circumpolar Inuit. Background information for cancer patterns in Canadian Inuits. *Acta Oncl* 1996;35(5):527-33.
- Getz B. The hip joint in Lapps. *Acta Orthop Scand* 1955(Suppl XVIII);18. Pp. 81 Munksgaard, Copenhagen 1955.
- Giesbrecht GG. The respiratory system in a cold environment. *Aviat Space Environ Med* 1995;66(9):890-902.
- Gilman A, Ayotte P, Dewailly E, Dudarev A, Bonefeld-Jørgensen EC, Muckle G. et al. Chapter 8. Public Health and Efforts of Contaminants. In: International Arctic Monitoring and Assessment Report (AMAP). Human Health in the Arctic 2009. Oslo 2009:143-90.
- Gissler M, Vuori E, Rasimus A ja Ritvanen A. Lisääntymistilastot 2000. Stakes Tilastoraportti 2002;3. Helsinki 2002:59. Finnish
- Giovannucci E. *Cancer Causes Control* 2005;16(2):83-95.
- GLOBOCAN 2012. WHO: International Agency for Research on Cancer. <http://globocan.iarc.fr/ia/world/atlas.html>
- Guggisberg M, Hessel PA, Michaelchuk D. Particulate matter and gaseous contaminants in indoor environments in an isolated northern community. *Int J Circumpolar Health* 2003;62(2):120-9.

- Hakko H, Räsänen P, Tiihonen J. Seasonal variation in suicide occurrence in Finland. *Acta Psychiatr Scand* 1998;98:92-7.
- Haldorsen T, Tynes T. Cancer in the Sami population of North Norway, 1970-1997. *European Journal of Cancer Prevention* 2005;14:63-8.
- Hansson H. Epidemiology of oral conditions in Skolt Lapps. In: Schephard RJ, Itoh S. (eds.). *Circumpolar Health 1974. Proceedings of the 3rd International Symposium*. Yellowknife, NWT. Toronto 1976:425-32.
- Harila V, Valkama V, Sato K, Tolleson S, Hanis S, Chung H, Kau C, Pirttiniemi P. Occlusal asymmetries in children with congenital hip dislocation. *Eur J Orthop* 2012;34(3):307-11. doi: 10.1093/ejo/cjr004. Epub 2011 Feb 8.
- Harju T, Mäkinen T, Näyhä S, Laatikainen T, Jousilahti P, Hassi J. Cold-related respiratory symptoms in the general population. *Clin Respir J* 2010;4(3):176-85. doi: 10.1111/j.1752-699X.2009.00172.x.
- Harvald B. Disease prevalence in Greenland. *Proceedings of the second International Symposium on Circumpolar Health*. Oulu, Finland, June 21-24, 1971. *Acta Socio-Medica Scandinavica* 1972:203-5.
- HASL "Announced nuclear detonations 1945-1962, United States, United Kingdom, Republic of France, Union of Soviet Socialist Republics, compiled by the atmospheric radioactivity research project, meteorological research projects", US Weather Bureau, Rep HASL-142. 1964:218-42.
- Hassan AA, Sandanger TM, Brustad M. Selected Vitamins and Essential Elements in Meat from Semi-Domesticated Reindeer (*Rangifer tarandus tarandus* L.) in Mid - and Northern Norway: Geographical Variations and Effect of Animal Population Density. *Nutrients* 2012;4:724-39.
- Hassi J, Rytönen M, Kotaniemi J, Rintamäki J. Impacts of cold climate on human heat balance, performance and health in circumpolar areas. *Int J Circumpolar Health* 2005; 64:459-67.
- Hassler S, Sjölander P, Barnekow-Bergkvist M, Kadesjö A. Cancer risk in the reindeer breeding Sami population of Sweden 1961-1997. *Eur J Epidemiol* 2001;17:969-76.
- Hassler S, Sjölander P, Johansson R, Grönberg H, Damberg L. Fatal accidents and suicide among reindeer-herding Sami in Sweden. In: Leppäluoto J. (ed.). *Circumpolar Health 2003*. *Int J Circumpolar Health* 2003;63(Suppl 2):384-8.
- Hassler S, Johansson R, Sjölander P, Grönberg H, Damberg L. Causes of death in the Sami population of Sweden 1961-2000. *Int J Epidemiol* 2005;34:623-9.

- Hassler S, Sjölander P, Grönberg H, Johansson R, Damber L. Cancer in the Sami population of Sweden in relation to lifestyle and genetic factors. *Eur J Epidemiol* 2008;23:273-80.
- Hasunen K, Pekkarinen M. Nutrient intake of adult Finnish Lapps. *Nord Council Arctic Med Res Rep* 1975;13:15-32.
- Hasunen K, Möttönen H. Food consumption and intake of iron and potassium by Finnish Lapps in 1971 and 1976. Department of Radiochemistry, University of Helsinki, preliminary report (U.S. Energy Research and Development Administration Annual Report 76:89. International Microcard Series COO-3011-6.
- Hasunen K, Pekkarinen M. The dietary intake of Finnish Skolt children. In: Shephard RJ, Itoh S. (eds.). *Circumpolar Health 1974. Proceedings of the third International Symposium on Circumpolar Health, Yellowknife, Canada 1974*. Toronto: University of Toronto Press 1976:135-41. ISBN O-8020-3333-4.
- Hasunen K, Muhonen M, Sahi T, Kirjarinta M. Dietary intake in cases of lactose malabsorption in a Finnish Lapp population. *Nordic Council Arct Med Res Rep* 1977;17:3-20.
- Hasunen K, Kalavainen M, Keinonen H, Lagström H, Lyytikäinen A, Nurtila A, Peltola T, Talvia S. *The Child, Family and Food. Nutrition recommendations for infants and young children as well as pregnant and breastfeeding mothers*. Helsinki 2004:75. (Publications of the Ministry of Social Affairs and Health, ISSN 1236-2050, 2004:11, ISBN 952-00-1528-0). Available at: <http://www.ravitsemusneuvottelukunta.fi/attachments/vrn/lapsi.perhe.ruoka.pdf> Finnish.
- Helakorpi S, Patja K, Prättälä R, Uutela A. Suomalaisen aikuisväestön terveystietäytyminen ja terveys, kevät 2005. [Health Behavior among Finnish Adult Population, Spring 2005] *Kansanterveyslaitoksen julkaisuja*, B18/2005. ISBN 951-740-540-5. Table 41 B.
- Helakorpi S, Pajunen T, Jallinoja P, Virtanen S, Uutela A. Suomalaisen aikuisväestön terveystietäytyminen ja terveys, kevät 2010. [In Finnish. Health Behavior among Finnish Adult Population, Spring 2010.] *Terveyden ja hyvinvoinnin laitos (THL), Raportti 15/2011*. Helsinki 2011. ISBN 978-952-245-473-7. The map is made by Toni Partama 2013.
- Helakorpi S, Uutela A, Prättälä R, Puska P. Suomalaisen aikuisväestön terveystietäytyminen ja terveys, kevät 1999. [Health Behavior and Health among Finnish Adult Population, Spring 1999.] Publication of the National Public Health Institute B19/1999. Helsinki 1999. Table 36 A

- Helander J. Suomen saamelaisväestö ja heidän elinkeinonsa. Sámi Instituhtta. DIEÐUT 1991;2:26,35. Finnish.
- Helkimo M, Carlsson GE, Hedegård B, Helkimo E, Lewin T. Function and dysfunction of the masticatory system in Lapps in Northern Finland. *Svensk Tandläkare Tidskrift*.1972;65:95-105.
- Hermansen R, Njølstad I, Fønnebo V. Physical activity according to ethnic origin in Finnmark county, Norway. The Finnmark study. *Int J Circumpolar Health* 2002;61;189-200.
- Hetta OM, Keskitalo AI, Somby P, Vandbakk Ø, Nordtsletta A, Solbakk R. Views on alcoholism in the Sami areas of Finnmark. In: Hirvonen J. (ed.). Symposium on alcohol problems in northern regions. Alta, Norway, May 5-6, 1977. *Nordic Council Arct Med Res Rep* 1978;21:42-48.
- Hildes JA, Schaefer O, Sayed JE, Fitzgerald EJ, Koch FA. Chronic lung disease and cardiovascular consequences in Igkooligmiut. *Circumpolar Health* 1974. In: Shephard RJ, Itoh S. (eds.). *Proceedings of the Third International Symposium on Circumpolar Health*, Yellowknife, Canada 1974. Toronto: University of Toronto Press 1976:327-31.
- Hildes JA, Schaefer O. The changing picture of neoplastic disease in the western and central Canadian arctic (1950-1980). *Can Med Assoc J* 1984;130:25-32.
- Hinkula M. Incidence of gynaecological cancers and overall and cause specific mortality of grand multiparous women in Finland. Thesis. University of Oulu. Oulu 2006. *Acta Univ Oul D* 870, 2006. ISBN 951-42-8009-1 (PDF). ISSN 1796-2234.
- Hirayama T. Life-Style and Mortality. A large-Scale Census-Based Cohort Study in Japan. Wahrendorf J. (ed). *Contributions to Epidemiology and Biostatistics*. Vol 6. Karger 1990. SBN 3-8055-5201-7.
- Hirsch R, Lin JP, Scott WW, Ma LD, Pillemer SR, Kastner DL, Jacobsson LT, Bloch DA, Knowler WC, Bennett PH, Bale SJ. Rheumatoid arthritis in the Pima Indians: the intersection of epidemiologic, demographic, and genealogic data. *Arthr Rheum* 1998;41(8):1464-9.
- Hirvelä-Koski V, Haukisalme V, Kilpelä S-S, Nylund M, Koski P. *Echinococcus granulosus* in Finland. *Veterinary Parasitology* 2003;111:175-92.
- Holck P, Day GE, Provost E. Mortality trends among Alaska Native people: successes and challenges. *Int J Circ Health* 2013;72: 21185 - <http://dx.doi.org/10.3402/ijch.v72i0.21185>

- Hubert A, Robert-Lamblin J, Hermann M. Environmental factors, dietary behaviours, and nasopharyngeal carcinoma: Anthropological approach. In: Fortuine R. (ed.). Circumpolar Health 84. Proceedings of 6th International Congress on Circumpolar Health. Anchorage, Alaska 13-18 May 1984. University of Washington Press 1985:261-5. ISBN 0-295-96202-X
- Huovila S. Lämpöolojen vaihtelurajat Pohjois-Suomessa. In Rapeli P. (ed.). Lapin ilmastokirja. Lapin Tutkimusseura. Rovaniemi 1974:18-22.
- Håglin L. Nutrient intake among Saami people today compared with an old, traditional Saami diet. In: Postl BD, Gilbert P, Goodwill J, Moffatt MEK, O'Neil JD, Sarsfield PA, Young TK. (eds.). Circumpolar Health 90. Proceedings of the 8th International Congress on Circumpolar Health. Whitehorse, Yukon, May 20-25, 1990. University of Manitoba Press, Winnipeg, Manitoba 1991:741-6. ISBN 0-88755-155-6.
- Hälinen K, Sikkilä K. Poromiesten ravinnon käyttö. In: Näyhä S, Hassi J. (eds.). Poronhoitajien elintavat, työ ja terveys. [Life style, work and health of Finnish reindeer herders]. Kansaneläkelaitoksen julkaisuja.1993;127:72-83. Publications of the Social Insurance Institution, Finland, ML:127,1993:72-83. In Finnish with English summary
- IASC, International Arctic Science Committee. Effects of Increased Ultraviolet Radiation in the Arctic. Oslo 1995:7-8.
- Inari municipality 2013, Social and health services. [Cited 15Aug 2013]. Available at: <http://www.inari.fi/fi/palvelut/sosiaali-ja-terveyspalvelut.html>
- Index mundi. 2012. Infant mortality [Cited 29 Sept 2014]. Available at: <http://www.indexmundi.com/g/r.aspx?c=fi&v=29>
- International Classification of Diseases (ICD-10) compiled by the World Health Organisation (WHO). Geneva 1992. Sosiaali- ja terveystieteiden tutkimus- ja kehittämiskeskus 1995. Finland, Rauma 1995. Finnish, Swedish, Latin.
- Isomäki H. Den reumatoida artritens epidemiologi. Nord Med 1994;109:215-7. [Epidemiology of the arthritis rheumatoides]. Swedish.
- Itkonen T I. Lapparnas forekomst i Finland. Ymer 1947. Stockholm 1947:43-57.
- Itkonen T I Suomen Lappalaiset vuoteen1945. II osa. [The Finnish Lapps until 1948. Part II.] Finnish. WSOY Porvoo 1948:449-74.
- Jacobsson LTH, Hanson RL, Knowler WC, Pillemer S, Pettitt DJ, Mccance DR, Bennett PH. Decreasing incidence and prevalence of rheumatoid arthritis in Pima Indians over a twenty five-year period. 1994;37(8):1158-65.

- Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. *CA Cancer J Clin* 2011; 61: 69-90.
- Johnsen K, Gran JT, Dale K, Husby G. The prevalence of ankylosing spondylitis among Norwegian Samis (Lapps). *J Rheumatol* 1992;19:1591- 94.
- Johnsen K, Goll R, Reikerås O. Acetabular dysplasia as an aetiological factor in development of hip osteoarthritis. *Int Orthop* 2009;33: 653-7.
- Jokelainen A, Pekkarinen M, Roine P, Miettinen JK. The diet of Finnish Lapps. *Z Ernährungswiss* 1962;3:110-17.
- Jokelainen A. Diet of the Finnish Lapps and its caesium-137 and potassium contents. Thesis. *Acta Agralia Fennica* 103. Hämeenlinna 1965: 63-8, 81, 125-8.
- Kaaja R. Naisten sepelvaltimotaudin vaaratekijät. *Duodecim* 2003;24:24-36. [The risk factors for ischemic heart disease among women]. Finnish.
- Kaminsky VI. Medical care of the indigenous peoples in the Lovozero county. In: Seurujärvi-Kari I, Kulonen A-M. (eds.). *Essays on indigenous identity and rights. Yliopistopaino. Helsinki* 1996:
- Karjalainen P, Marin R. 1979. Erityisryhmätutkimus. Osa: Saamelaiset. Sosiaali- ja terveystieteiden tutkimusosasto. Julkaisuja 10/1979. Pp 70. Finnish.
- Karlsson J. Maximum oxygen uptake in Skolt lapps. *Arctic Antropol* 1970;7:19-20.
- Karvonen J, Sahi T, Kirjarinta M, Tiilikainen A. Skin diseases in a Finnish Lapp population. *Nordic Council Arct Med Res Rep* 1976;16:38-43.
- Kauranen P, Miettinen JK. Po-210 and Pb-210 in the Arctic Food chain and the natural radiation exposure of Lapps *Health Phys* 1969;16:287-95.
- Kavli G, Stenvold E, Vandbakk O. Low Prevalence of Psoriasis in Norwegian Lapps. *Acta Derm Venereol (Stockh)* 1985;65:262-3.
- Kegel M, Dam H, Fatuma A, Bjerregaard P. The prevalence of seasonal affective disorder (SAD) in Greenland is related to latitude. *Nord J Psych* 2009;63(4):331-5.
- Kela Mortality index and Morbidity index. NTO79A.[Cited 12 Nov 2014]. Available at:
http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NITo79AL&YKIELI=E
- Kela Health barometer 2015: Diseases of public health importance. [Cited 27 Jan 2014] Available at:
http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NITo83AL&YKIELI=E

- Key T. Risk factors for prostate cancer. *Cancer Surveys* 1995;23:63-77.
- Kirjarinta L, Eriksson AW. Preliminary studies on diabetes mellitus in Finnish Lapps. *Nordic Council Arct Med Res Rep* 1976;15:41-7.
- Kirjarinta L. Health care in Inari and Utsjoki, Northern Finland. *Nordic Council Arct Med Res Rep* 1977;20:51-61.
- Kirjarinta L. Skin diseases of Finnish Lapps. Poster presentation in 7th International Congress on Circumpolar Health. Umeå, Sweden, June 8-12. 1987.
- Kirjarinta M, Yrjänheikki E. Selvitys eräiden lohensukuisten kalojen elohopeapitoisuudesta. Kuopion korkeakoulun julkaisuja. *Luonnontieteet. Sarja: Tilastot ja selvitykset* 3:12,1982.[Mercury concentrations of some salmon fishes]. Finnish.
- Kirkegaard J. Incidence of pancreatic cancer in Greenland 2000-2010. *Int J Circumpolar Health* 2013;63(Suppl 2):290-1.
- Kjærgaard J, Bjerregaard P. Incidence of myocardial and cerebral infarction in Nuuk, Greenland. In: Leppäluoto J. (ed.). *Circumpolar Health Supplement 2/2004. Proceedings of the 12th International Congress on Circumpolar Health. September 10-14 2003 Nuuk, Greenland. Int J Circumpolar Health* 2004;63(Suppl 2):290-1.
- Klaukka T, Kaarela K. Reumasairaudet ja niiden lääkehoito Kelan tietojen valossa vuonna 2005. *Suomen Lääkärilehti* 2006;61(26):2870-2. [The rheumatic diseases and their pharmacotherapy in the light of the statistics of Social Insurance Institution of Finland 2005]. Finnish.
- Kleinerman RA, Smith SA, Holowaty E, Hall P, Pukkala E, Vaalavirta L, Stovall M, Weathers R, Gilbert E, Aleman BMP, Kaijser M, Lynch CF, Doros GM, Travis LB, Morton LM, Curtis RE. Radiation dose and subsequent risk for stomach cancer in long-term survivors of cervical cancer. doi: <http://dx.doi.org/10.1016/j.ijrobp.2013.04.010>.
- Klen T. Accidents in the Arctic. A psychological point of view. *Arct Med Res* 1992;51(Suppl 7):70-4.
- Knekt P, Aromaa A, Maatela J et al. Serum selenium and subsequent risk of cancer among Finnish men and women. *J Int Cancer Inst* 1990;82:864-8.
- Knowler WC, Pettitt DJ, Savage PJ, Bennett PH. Diabetes incidence in Pima Indians: contributions of obesity and parental diabetes. *Am J Epidemiol* 1981;113(2):144-55.
- Koivusalo M, Mussalo-Rauhamaa H, Soininen L. Luoteis-Venäjän ilmansaasteet ja terveys.. *Sosiaali-ja terveysministeriön selvityksiä* 1996:6:1-76. Helsinki

1977. Ministry of Social- and Health Affairs. 1996;6:1-76. ISBN 952-00-0254-5. [The air pollution of North West Russia and health]. Finnish.
- Kosta L, Byrne AR, Zelenko V. Correlation between selenium and mercury in man following exposure to inorganic mercury. *Nature* 1975;254(5497):238-9.
- Kotaniemi J-T, Latvala J, Lundbäck B, Sovijärvi A, Hassi J, Larsson K. Does living in a cold climate or recreational skiing increase the risk for obstructive respiratory diseases or symptoms? *Int J Circumpolar Health*. 2003;62(2):142-57.
- Koutonen J. Kolttasaamelaisten sosiaaliin tekijöihin vaikuttavat seikat. Sairaanhoidon vuosikirja 1972. Sairaanhoidajien koulutussäätiö 1972:261-94. [Factors affecting the development of social condition among the Skolt Lapps]. Finnish with English summary.
- Korhonen M. Die Konjugation im Lappischen. Morphologisch-historische Untersuchung I. Die finite Formkategorien. *Suomalais-Ugrilaisen seuran toimituksia* 143. Helsinki 1967.
- Krog J, Ålvik M, Lund-Larsen K. Investigations of the circulatory effects of submersion of the hand in ice water in the Finnish Lapps, the Skolts. *Federation proceedings* 1969;28(3):1135-7.
- Kromann N, Green A. Epidemiological studies in the Upernavik district, Greenland. *Acta Med Scand* 1980;208:401-6.
- Kulonen U-M. North Sami language. In: Kulonen U-M, Seurujärvi-Kari I, Pulkkinen R. (eds.). *The Saami. A Cultural Encyclopedia*. Suomalaisen Kirjallisuuden Seuran toimituksia 925. Vammala 2005:66:177, 248.
- Kurtio P, Pukkala E, Ilus T, Rahola T, Auvinen A. Radiation doses from global fallout and cancer incidence among reindeer herders and Sami in Northern Finland. *Occup Environ Med* 2010;67:737-43.
- Köngas R. Moottorikelkkaonnettomuudet 1992-2003. Liikennevakuutuskeskus. Vakuutusyhtiöiden liikenneturvallisustoimikunta (VALT) 2004. [The snowmobile accidents in 1992-2003]. Finnish. ISBN 951-9346-54-6
- Köngas R. Moottorikelkkaonnettomuudet 1992-2005. Liikennevakuutuskeskus. Vakuutusyhtiöiden liikenneturvallisustoimikunta (VALT) 2006. [The snowmobile accidents in 1992-2005]. Finnish.
- Laatikainen T, Tapanainen H, Alfthan G, Salminen I, Sundvall J, Leiviskä J, Harald K, Jousilahti P, Salomaa V, Vartiainen E. *Finriski* 2002. Tutkimus kroonisten kansantautien riskitekijöistä, niihin liittyvistä elintavoista, oireista, psykososiaalisista tekijöistä ja terveystalvelujen käytöstä.

- [Finriski 2002. Risk factors of the chronic national diseases of Finland]
Publication of the National Public Health Institute 2003;B7. Finnish.
[Cited 23 Aug 2013]. Available at:
<http://www.julkari.fi/bitstream/handle/10024/78520/b72.pdf?sequence=1>
- Lanier AP. Cancer in circumpolar Inuit. Background information for Alaska. *Acta oncol* 1996;35(5):523-55.
- Lanier AP, Blot WJ, Bender TR, Fraumeni JF. Cancer in Alaskan Indians, Eskimos and Aleuts. *JNCI* 1980;65:1157-9.
- Lanier AP, Williams J, Stutzman CD. Radiation and cancer in Alaskan Natives: Part 2. *Alaska Medicine* 1985;27(4):86-8.
- Lanier AP, Alberts SR. Cancers of the buccal cavity and pharynx in circumpolar Inuit. *Acta Oncol* 1996;35(5):545-52.
- Lanier AP, Holck P, Kelly J, Smith B, McEvoy T. Alaska Native cancer survival. *Alaska Medicine* 2001;3(43):61-83.
- Lapin komitean mietintö 1905. [State Committee of Lapp Affairs 1905]. Finnish.
- Larsson SC, Bergkvist L, Wolk A. Processed meat consumption, dietary nitrosoamines and stomach cancer risk in a cohort of Swedish women. *Int J Cancer* 2006;119(4):915-9.
- Laukkanen J, Kettunen R. Fyysinen kunto ja sepelvaltmotauti. *Suomen Lääkärilehti* 2003;45:4585-90. [Physical fitness and coronary artery disease]. Finnish, English summary.
- Laurila A, Bloigu A, Näyhä S, Hassi J, Leinonen M, Saikku P. Chlamydia pneumoniae and Helicobacter pylori infections in Sami and Finnish reindeer herders. *Int J Circumpolar Health* 1997;56(3):70-5.
- Laurila A, Bloigu A, Näyhä S, Hassi J, Leinonen M, Saikku P. Association of Helicobacter pylori infection with elevated serum lipids. *Atherosclerosis* 1999; 142; 207-210.
- Lehtinen S, Luoma P, Näyhä S et al. Apolipoprotein A-IV polymorphism in Saami and Finns: frequency and effect on serum lipid levels. *Ann Med* 1998;30(2):218-23.
- Lehtiranta J, Seurujärvi-Kari I. 1992. Saamelaiset. In: Laakso J. (ed.). Uralilaiset kansat. Tietoa Suomen sukukielistä ja niiden puhujista. WSOY 1992:123-55. [The Sami]. Finnish.
- Lehtola T. Kolmen kuninkaan maa. *Historian Inari. Gummerrus* 1998:327, 331-334.

- Lehtola V-P. Sami livelihoods. [Cited 1 April 2013]. Available at: <http://www.galdu.org/web/index.php?sladja=25&vuolitsladja=11&vuolitvuolitsladja=4&giella1=eng>
- Leppäluoto J. Valo ja hedelmällisyys. *Duodecim*.2005;121(23):2551-4. [Light and fertility]. Finnish.
- Lewin T. History of the Skolt Lapps. A literary Study. . Proceedings of the Finnish Dental Society. 1971;67 (I):13-23.
- Lewin T, Hedegård B. The internordic IBP/HA Studies of the Skolt Lapps in Northern Finland 1966 to 1969. Proceedings of the Finnish Dental Society. 1971;67 (I):9-12.
- Lewin T, Rundgren Å, Forsius H, Eriksson A W. Demography of the Skolt Lapps in Northern Finland. Proceedings of the Finnish Dental Society. 1971;67 (I):24-42.
- Lewin T, Rundgren Å, Louekari L, Forsius H. Child mortality among the Skolt Lapps. Proceedings of the Finnish Dental Society. 1971;67 (I):43-54.
- Lewin T, Hedegård B. Human biological studies among Skolts and other Lapps. A survey of earlier literature. Introduction to the biological characteristics of the Skolt Lapps. Proceedings of the Finnish Dental Society. 1971;67 (I):63-69.
- Linnanmäki E. Espanjantauti Suomessa. Influenssapandemia 1918-1920. Suomalaisen kirjallisuuden seura. *Bibliotheca Historica*. Tampere 2005;108-126.[Spanish disease in Finland Influenza pandemic 1918-1920]. Finnish, English summary.
- Lodenius M, Seppänen A. Hair mercury contents and fish eating habits of people living near a Finnish manmade reservoir. *Chemosphere* 1982;755-9.
- Lodenius M, Seppänen A, Herranen M. Accumulation of mercury in fish and man from reservoirs in northern Finland. *Water Air Soil Pollut* 1983;19:237-46.
- Lukjantschenko T. Lapps in the Soviet Union. In: Brodbent N. (ed.). Readings in Saami history, culture and language. Umeå University 1989:87-93. ISSN 0283-9687
- Lund E, Melhus M, Hansen KL, Nystad T, Broderstad AR, Selmer R, Lund-Larsen PG. Population based study of health and living conditions in areas with both Sámi and Norwegian populations--the SAMINOR study. *Int J Circumpolar Health*. 2007;66(2):113-28.
- Lund E, Brustad M, Høgmo A. The Sami - Living conditions and health. *Int J Circumpolar Health* 2008;67(1):6-8.

- Luoma PV, Näyhä S, Pyy L, Korpela H, Hassi J. High blood cadmium and mercury concentrations in reindeer herders in northern Finland west of Kola Peninsula. Arctic Centre Publications. University of Lapland, Rovaniemi 1992;4:349-51.
- Luoma P, Näyhä S, Pyy L, Korpela H, Sikkilä K, Hassi J. Blood mercury and serum selenium concentrations in reindeer herders in the arctic area of northern Finland. Arch Toxicol Suppl 1992;15:172-5.
- Luoma PV, Näyhä S, Pyy L, Hassi J. Association of blood cadmium to the area of residence and hypertensive disease in Arctic Finland. Sci Total Environ 1994;160-161:571-5.
- Luoma P, Näyhä S, Pyy L, Korpela H, Sikkilä K, Hassi J. Altistuminen raskasmetalleille Lapissa. Duodecim 1994;5:487-94.
- Luoma PV, Näyhä S, Sikkilä K, Hassi J. High serum alpha- tocopherol, albumin, selenium and cholesterol, and low mortality from coronary heart disease in northern Finland. J Intern Med 1995;237:49-54.
- Lupin A J. Ear disease in western Canadian natives-- a changing entity--and the results of tympanoplasty. In: Circumpolar Health 1974. Schephard RJ, Itoh S. (eds.). Proceedings of the 3rd International Symposium. Yellowknife, NWT. University of Toronto Press. Toronto 1976:425-32.
- Luriel G, Matsuno RK, Wilkens LR, Thompson PJ, Ollberding NJ, Canrey ME, Goodman MT. Cataract and ovarian carcinoma: Is the vitamin D hypothesis alive? Cancer Epidemiol Biomarkers Prev 2011;20:2. doi: 10.1158/1055.EPI-11-0721
- Lyngé I. Suicide in Greenland. Arct Med Res 1994;53(2):551-4.
- Lähteenmäki M. Kalotin kansaa. Rajankäynnit ja vuorovaikutus Pohjoiskalotilla 1808-1889. Suomalaisen Kirjallisuuden Seura. Helsinki 2004. ISBN 951-746-599-8. p.290.
- Lääkintöhallitus 1970. Tietoja ekinokokkitaudista. Helsinki 1970. 6 Pp. Valtion painatuskeskus. [Information about echinococcus-disease]. Finnish.
- Mailman M, Bodaly, Paterson MJ, Thompson S, Flett RJ. Low-level experimental selenite additions decrease mercury in aquatic food chains and fish muscle but increase selenium in fish gonads. Arch Environ Contam Toxicol. 2014 66(1):32-40.
- Manney GL, Santee ML, Rex M, Livesey NJ, Pitts MC, Veefkind P, Nash ER et al. Unprecedented Arctic ozone loss in 2011. Nature 478:469-75.

- Markkula M-L, Rantavaara A. Consumption of mushrooms and other wild food products in Finland. In: Proceedings of the 11th Meeting of the Nordic Society for Radiation Protection and the 7th Nordic Radioecology Seminar 1997;371-6.
- McMahon BJ. Viral hepatitis in the Arctic. Circumpolar Health 2003. Proceedings of the 12th International Congress on Circumpolar Health Sept 10-14, 2003 Nuuk. Int J Circumpolar Health 2004;63 (Suppl 2):41-3.
- McGowan L, Norris HJ, Hartge P, Hoover R, Leshner L. Risk factors in ovarian cancer. Eur J Gynaecol Oncol 1988, 9(3):195-9.
- Mellbin T. The children of Swedish nomad Lapps. A study of their health, growth and development. Acta Paediatr Suppl 1962;131:1-97.
- Middaugh J. Epidemiology of Injuries in Northern areas. Arct Med Res 1992;51:5-14.
- Miettinen JK, Paakkola O, Näsänen R, Vuorinen A, Merten D. Arctic food chains. Nature 1961;189:324.
- Miettinen JK. Investigations of radioactivity in man and his environment in the Finnish Lapland. Proc Ann Acad Sci Fenn. 1965:245-58.
- Miller AD, Gaudette LA. Breast cancer in Circumpolar Inuit. Acta Oncol 1996;35:577-80.
- Morottaja M. The Inari Samis. [Cited 15 Jan 2013]. Available at: <http://www.samimuseum.fi/anaras/english/yleistietoa/yleistietoa.html>
- Moshnikoff S. Skolt Sami writing. In: Kulonen U-M, Seurujärvi-Kari I, Pulkkinen R. (eds.). The Saami. A Cultural Encyclopedia. Suomalaisen Kirjallisuuden Seuran toimituksia 925. Vammala 2005:400.
- Mouratoff GJ, Carroll NV, Scott EM. Diabetes Mellitus in Athabaskan Indians in Alaska. Diabetes 1969;18(1):29-32.
- Mudge GH, Grossman W, Mills RM, Lesch M, Braunwald E. Reflex increase in coronary vascular resistance in patients with ischemic heart disease. N Engl J Med 1976;295(24):1333-7.
- Mussalo-Rauhamaa H. Accumulation of plutonium from fallout in southern Finns and Lapps. Thesis. University of Helsinki, Department of Radiochemistry. Report Series in radiochemistry 4/1981.
- Mussalo-Rauhamaa H, Häsänen E, Pyysalo H et al. Occurrence of beta-hexachlorohexane in breast cancer patients. Cancer 1991;66:2124-8.

- Mussalo-Rauhamaa H, Soininen L, Piepponen S, Lehto J, Koivusalo M.
Selenium concentration in the serum of the inhabitants of northeast Lapland. In: Tikkanen E, Varmola M, Katermaa T. (eds.). Symposium on the State of the Environment and Environmental Monitoring in Northern Fennoscandia and Kola Peninsula. Arctic Centre 1992:359-61.
- Mussalo- Rauhamaa H, Panzar P. Selenium and DDE in breast fat of breast cancer patients; their relationships to hormone receptors in breast tissue. *J Natl Cancer Inst* 1993;85:1964-6.
- Mussalo-Rauhamaa H, Kantola M, Seppänen K, Soininen L, Koivusalo M.
Trends in the concentrations of mercury, copper, zinc and selenium in inhabitants of north-eastern Finnish Lapland in 1982-1991. A pilot study. *Arct Med Res* 1996;55:83-91.
- Mäkinen TM, Jokelainen J, Näyhä S, Laatikainen T, Jousilahti P, Hassi J.
Occurrence of frostbite in the general population--work related and individual factors. *Scand J Work Environ Health* 2009;35:384-93.
- Naylor JL, Schraer CD, Mayer AM, Lanier AP, Treat CA, Murphy NJ.
Diabetes among Alaska Natives: A review. *Int J Circumpolar Health* 2003;62(4):363-87.
- Negri E, Bosetti C, Fattore E, La Vecchia C. Environmental exposure to polychlorinated biphenyls (PCBs) and breast cancer: a systematic review of the epidemiological evidence. *Eur J Cancer Prev.* 2003; 12(6):509-16.
- Newcomer AD, McGill DB, Thomas P, Hofman AF. Tolerance to lactose among lactase-deficient American Indians. 1978;74:44-6.
- Nickul E. Suomen saamelaiset vuonna 1962. [The Sami in Finland in the year 1962]. Selostus Pohjoismaiden saamelaisneuvoston suorittamasta väestöntutkimuksesta. Tilastotieteen pro gradu-tutkielma Helsingin Yliopiston Tilastotieteen laitos 1968. [M Sci thesis. University of Helsinki. Institute of Statistics. 1968]. Finnish.
- Nickul K. The Skolt Lapp community Suenjelsijd during the Year 1938. *Acta Lapponica* V. Gebers Forl. Stockholm 1948.
- Nickul K. Saamelaiset kansana ja kansalaisina. Suomalaisen kirjallisuuden seuran toimituksia 297. Helsinki 1970. Finnish.
- Nielsen NH, Storm HH. Cancer in Circumpolar Inuit. Background information for the cancer pattern in Greenland. *Acta Oncol* 1996;35(5):535-37.
- Nieminen M. Meat production and chemical composition of the reindeer meat. In: Van Hoven W, Ebedes H, Conroy A. (eds.). *Wildlife Ranching: A*

- celebration of Diversity. Proceedings of the 3rd International Wildlife Ranching Symposium, October 1992. Pretoria. South Africa 1994:196-205.
- Nieminen P, Panychev D, Lyalyushkin S, Komarov G, Nikanov A, Borisenko M, Kinnula VL, Toljamo T. Environmental exposure as an independent risk factor of chronic bronchitis in northwest Russia. *Int J Circumpolar Health* 2013; 72;19742. - <http://dx.doi.org/10.3402/ijch.v72i0.19742>
- Nilsson LM, Dahlgren L, Johansson I, Brustad M, Sjölander P, Van Guelpen B. Diet and lifestyle of the Sami of southern Lapland in the 1930s-1950s and today. *Int J of Circumpolar Health* 2011;70(3):301-18.
- Njølstad I, Amesén E, Lund-Larsen PG. Cardiovascular diseases and diabetes mellitus in different ethnic groups. The Finnmark Study. *Epidemiology* 1998;9(5):550-6
- NORDCAN Graphics 2014. Engholm G, Ferlay J, Christensen N, Johannesen TB, Khan S, Køtlum JE, Miltner MC, Ólafsdóttir E, Pukkala E, Storm HH. NORDCAN: Cancer Incidence, Mortality, Prevalence and Survival in the Nordic Countries, Version 6.1. Association of the Nordic Cancer Registries. Danish Cancer Society. Available from <http://www.ancr.nu>, accessed on day/month/year. Available at: <http://www-dep.iarc.fr/NORDCAN/English/frame.asp> Visited in 4th April 2015.
- Norum J, Olsen A, Småstuen M, Nieder C, Broderstad AR. Health consumption in Sami speaking municipalities with regard to cancer and radiography. *Int J Circumpolar health* 2011;70(3):319-28. Available at: <http://www.circumpolarhealthjournal.net/index.php/ijch/article/view/17832/20313>
- Näyhä S. Mortality in northern Finland: Temporal trends and regional variations. In: Lång J. (ed.). *Geomedical Research in Relation to Geochemical Registrations*. Universitets forlaget. Oslo, 1984:63-70.
- Näyhä S. Seasonal variation in suicide and mental depression in Finland. In: Fortune R. *Circumpolar Health 84. Proceedings of 6th International Congress on Circumpolar Health*. Anchorage, Alaska 13-18 May 1984. University of Washington Press 1985:261-5. ISBN 0-295-96202-X
- Näyhä S. Spatial patterns of mortality in Northern Finland in 1961-1980. *Acta Univ Oul D151. Med. Publica* 5. Oulu, 1987. Pp. 75.
- Näyhä S. Low mortality from ischaemic heart disease in the Sami district of Finland. *Soc Sci Med* 1997;44(1):123-131.
- Näyhä S. Environmental temperature and mortality. *Int J Circumpolar Health* 2005;64:451-8.

- Näyhä S. Suicide mortality in Finnish Lapland by small areas, with reference to temporal trends. *Int J Circumpolar Health* 2009;68(3):224-34.
- Näyhä S, Korpela H, Pyy L, Hassi J. Effect of Soviet industry on blood cadmium in Finns. *Lancet*.1991;338:1593.
- Näyhä S, Videman T, Laakso M, Hassi J. Prevalence of low back pain and other musculoskeletal symptoms and their association with work in Finnish reindeer herders. *Scand J Rheumatol* 1991;20:406-13.
- Näyhä S, Hassi J. Poronhoitajien elintavat, työ ja terveyst. Kansaneläkelaitoksen julkaisuja 1993;127:130-3. [Life style, work and health of Finnish reindeer herders]. Finnish, English summary.
- Näyhä S, Hirvonen L, Hassi J. Tupakointi. In: Näyhä S, Hassi J. (eds.). Poronhoitajien elintavat, työ ja terveyst. [Life style, work and health of Finnish reindeer herders] Kansaneläkelaitoksen julkaisuja.1993;127:51-64, 223-4. [Smoking]. Finnish. English summary
- Näyhä S, Sikkilä K, Hassi J. Cardiovascular risk factor patterns and their association with diet in Saami and Finnish reindeer herders. *Circumpolar Health* 93. Proceeding of the 9th International Congress on Circumpolar Health Reykjavik, Iceland June 20-25, 1993. *Arctic Med Res* 1994;53(Suppl 2):301-4.
- Näyhä S, Anttonen H, Hassi J. Snowmobile driving and symptoms of the locomotive organs. *Arct Med Res* 1994;53(Suppl 3):41-4.
- Näyhä S, Väisänen E, Hassi J. Season and mental illness in an arctic area of northern Finland. *Acta Psych Scand* 1994;89:46-9.
- Näyhä S, Hassi J. Cold and mortality from ischaemic heart disease in northern Finland. *Arct Med Res* 1995;54:Suppl 2:19.25.
- Näyhä S, Hassi J, Jousilahti P, Laatikainen T, Ikäheimo TM. Cold-related symptoms among the healthy and sick of the general population: National FINRISK Study data, 2002. *Public Health* 2011;125(6):380-8
- Näätänen EK. Über die Anthropologie der Lappen in Suomi. *Ann Acad Sci Fenn* 1936;47(2):45-63.
- Odland JØ, Nieboer E, Romanova N, Thomassen Y, Lund E. Blood lead and cadmium and birth weight among sub-arctic and arctic populations of Norway and Russia. *Acta Obstet Scand* 1999;78:852-60.
- Official Statistics of Finland (OSF): Causes of death [e-publication]. ISSN=1799-5078. 2012, Quality Description, Causes of death 2012 . Helsinki: Statistics Finland [referred: 22.10.2014]. Access method: <http://www.stat.fi/til/>

- Omran AR. The Epidemiological transition: A theory of the epidemiology of population change. *The Milbank Quarterly* 2005;83(4):731-57.
- Ordoñez M, Brenner H. Vitamine D and cancer: an overview on epidemiological studies. *Adv Exp Med Biol* 2014;810:17-32.
- Outakoski J. Suicidal tendencies in the Lapp population. *Arct Med Res Rep* 1980;27:106-9.
- Paatero J, Dauvalter V, Derome J, Lehto J, Pasanen J, Vesala T, Miettinen J, Makkonen U, Kyrö E-M, Jernström J, Isaeva L, Derome K. Effects of Kola air pollution on the environment in the Western part of the Kola Peninsula and Finnish Lapland - Final report. Finnish Meteorologica Institute reports 2008:6. Paatsjoki-program. [Cited 12 Oct 2012] Available at: <https://helda.helsinki.fi/bitstream/handle/10138/1202/2008nro6.pdf>
- Palva IP, Finell B. Tuberculosis in Finnish Lapland. In: Circumpolar Health 1974. Schephard R J, Itoh S. (eds.). Proceedings of the 3rd International Symposium. Yellowknife, NWT. University of Toronto Press. Toronto 1976:331-4.
- Parkinson AJ, Butler JC. Potential impacts of climate change on infectious diseases in the Arctic. *Int J Circumpolar Health* 2005;64(5):478-86.
- Peehl DM, Krishnan AV, Feldman D. Pathways Mediating the Growth-Inhibitory Actions of Vitamin D in Prostate Cancer. *J. Nutr* 2003;33(7):2461S-2469S
- Pelto PJ. Snowmobile revolution. Technology and social change in the Arctic. California Cumming Publishing Company. Menlo Park 1973.
- Pekkarinen A, Kisko K, Anttonen H. Accidents in reindeer herding work. In: Linderholm H, Backman C, Broadbent N, Joelsson I. (eds.). Circumpolar Health 87. Proceedings of the 7th International Congress on Circumpolar Health. Umeå, Sweden, June 8-12, 1987. *Arct Med Res* 2088;47(Suppl 1):403-5.
- Pekkarinen A, Anttonen H, Hassi J. Prevention of accidents in reindeer herding work. *Arct Med Res* 1992;51(Suppl 7):59-63.
- Petridou E, Papadopoulos FC, Frangakis CE, Skalkidou A, Trichopoulos D. A Role of Sunshine in the Triggering of Suicide. *Epidemiology* 2002;13(1):106-9.
- Petrucelli N, Daly MB, and Feldman GL. Hereditary Breast and Ovarian Cancer due to mutations in BRCA1 and BRCA2. *Genetics in medicine* 2010;12:245-9.

- Pfohman M, Criddle LM. Epidemiology of intracranial aneurysm and subarachnoid haemorrhage. *J Neurosci Nurs* 2001;33(1):39-41.
- Pienta KJ, Esper PJ, Risk Factors for Prostate Cancer. *Ann Intern Med*. 1993;118(10):793-803. doi:10.7326/0003-4819-118-10-199305150-00007.
- Pitkänen A. Tasa-arvon toteutuminen saamelaiden hammashuollossa vuosina 1973-1988. *Ann Univ Turkuensis. Serie 156. Turku 2000*. Thesis. [The Fulfilment of equality in dental care of the Sami children in 1973-1988]. Finnish.
- Poikolainen K, Näyhä S, Hassi J. Alcohol consumption among male reindeer herders of Lappish and Finnish origin. *Soc Sci Med* 1992;35 (5):735-8.
- Prener A, Storm HH, Nielsen NH. Cancer of the male genital tract in Circumpolar Inuit. *Acta Oncol* 1996;35:589-93.
- Pukkala E. Use of record linkage in small-area studies. In: Elliot P, Guzik J, English D, Stern R. (eds.). *Geographical and environmental epidemiology*. Oxford: Oxford University Press, 1992:125-31.
- Pukkala E, Patama T. Syövän ajallinen ja alueellinen vaihtelu kartta-animaatioina Suomessa 1953-2008.[Temporal variation of cancer in Finland 1953.2008, animation] Finnish. Suomen Syöpärekisteri. [Cited 13 Oct 2012] Available at: <http://astra.cancer.fi/cancermaps/suomi5308/fi/>
- Pukkala E, Rautalahti M. Cancer in Finland. Publications from the Cancer Society of Finland 2013. Helsinki 2013: 26-41.
- Pukkala E, Söderman B, Okeanov A, Storm H, Rahu M, Hakulinen T, Becker N, Stabenow R, Bjarnadottir K, Stengrevics A, Gurevicius R, Glatte E, Zatonski W, Men T, Barlow L: Cancer atlas of Northern Europe. Cancer Society of Finland. Publication No. 62, Helsinki 2001 (69 pages + CD); ISSN 0585-9603 <http://www.cancerregistry.fi/atlasweb/index.htm>). ISSN 0585-9603.
- Pönkä A. Lead in the ambient air and blood of children in Helsinki. *Science of Total Environment*. 1998;219:1-5.
- Rahola T, Miettinen JK. Fallout levels of Cs-137 and some short life nuclides in Finnish Lapland during 1966-1976 in the food-chain lichen - reindeer - man. In: Miettinen JK. (ed.). *Radioactive foodchains in the subarctic environment*. Progress report. Aug 15 1976 - Nov 14 1977. Department of Radiochemistry. University of Helsinki. Reprint Series in Radiochemistry.
- Rahola T, Jaakkola T, Suomela M, Tillander M. Transfer of radionuclides from radioactive fallout to man in subarctic regions. Arctic Centre Publications. University of Lapland, Rovaniemi. 1992;4:349-51.

- Rasmus M. Saamen kielen ja kulttuurin tarpeet Suomessa. Publications of Giellagas Institute 2010, 13:39-42. Finnish
- Rautelin H, Kosunen TU. Helicobacter pylori infection in Finland. Annals of medicine 2004;36(2):82-8.
- Regnard J. Cold and the airways. Int J Sports Med 1992;13(Suppl 1) S182-4.
- Reijula K, Larimi E, Hassi J, Hannuksela M. Respiratory symptoms and ventilatory function among Finnish reindeer herders. Arct Med Res 1990;49:74-80.
- Rein K. Spedbarnsdødeligheten i Kautokeino 1946-1955. T Norske Legeforen 1956;76:815-16
- Rein K. Ekinokokksykdomen i Nord-Norge. Nordic Med 1957;58:1853-7. [Echinococcus disease in Northern Norway]. Norwegian.
- Riise T, Jacobsen BK, Gran JT. Incidence and prevalence of rheumatoid arthritis in the county of Troms, northern Norway. J Rheumatol. 2000;27(6):1386-9.
- RKTL 2013. Kalan kulutus. [The Consumption of fish in Finland] [Cited 28 April 2014]. Available at: http://www.rktl.fi/esikatselu/tilastot/aihealueet/kalan_kulutus/kalan_kulutus.html
- Rintala R, Venäläinen ER, Hirvi T. Heavy-metals in muscle, liver, and kidney from Finnish reindeer in 1990–91 and 1991–92. Bull Environ Contam Toxicol. 1995;54:158–65.
- Rissanen K. Radioaktiivisuus arktisella alueella. In: Mähönen O and Joki-Heiskala P. (eds.) AMAP-Arktisen ympäristön tila ja Suomen Lappi. Suomen Ympäristökeskus. Suomen ympäristö. Ympäristön suojele 120. Helsinki 1997:52-57.
- Roberts JE. Ultraviolet radiation as a risk factor for cataract and macular degeneration. Eye Contact Lens 2011;37(4):246-9.
- Rode A, Shephard RJ. Cardiorespiratory fitness on an arctic community. J Appl Physiol 1971;31:519-26.
- Rosenthal NE, Sack DA, Gillin C et al. Seasonal Affective disorder: a description of the syndrome and preliminary findings with light therapy. Arch Gen Psychiatry 1984;41:72-80.
- Rossi V. Auringonpaiste ja valaistus Lapissa. In Rapeli P. (ed.). Lapin ilmastokirja. Lapin Tutkimusseura 1974:10-17.
- Ruong I: Samerna i historien och nutiden. Aldus Akademi. Bonnier Fakta.

- Stockholm 1982.[The Sami in the past and today]. Swedish.
- Ryymim T. Forebygging av tuberkulose i Finnmark 1900–60. Tidsskr Nor Legeforen 2008;128(24):2864-7.[Prevention of tuberculosis in Finnmark]. Norwegian.
- Saamelaisasiain komitean mietintö 1952. Report 1952;12:9. [State Committee of Lapp Affairs 1952] Finnish:
- Saamelaiskomitean mietintö 1973. Helsinki 1973:46. [Report of State Committee of Sami Affairs 1973]. Finnish.
- Saarijärvi S, Lauerma H, Helenius H, Saarilehto S. Seasonal disorders among rural Finns and Lapps. Acta Psychiatr Scand 1999;99:95-101.
- Saghier AA, Kabanja JH, Afreen S, Sagar M. Gastric cancer: Environmental risk factors, treatment and prevention. J Carcinogene Mutagene 2013;14. [Cited 9 Aug 2013]. Available at: <http://dx.doi.org/10.4172/2157-2518.S14-008>
- Sahi T, Isokoski M, Jussila J, Launiala K, Pyörälä K. Recessive inheritance of adult-type lactose malabsorption. Lancet 1973;2:823.
- Sahi T, Eriksson AW, Isokoski M, Kirjarinta M. Lactose malabsorption in Finnish Lapps. Preliminary report. Arct Med Res Rep 1974;6:11-12.
- Sahi T, Eriksson AW, Isokoski M, Kirjarinta M. Isolated adult-type lactose malabsorption in Finnish Lapps. In: Shephard RJ, Itoh S. (eds.). Circumpolar Health 1974. Proceedings of the 3rd International Symposium on circumpolar health, Yellowknife, Canada. University of Toronto Press 1976:145-9.
- Sahi T, Vuori E, Kilpiö J, Kirjarinta M. Mineral content of drinking water in Finnish Lapland. Nordic Council Arct Med Res Rep 1978;23:3-9.
- Sahi T. Epidemiologic aspects of gastrointestinal diseases with special references to hypolactasia in Skolt Lapps. Acta Comment Univ Tartu 1989;854:112-28.
- Sami in Sweden 2014. Available at: <https://sweden.se/society/sami-in-sweden/> [Cited 15 Nov 2014].
- Sandblad H. Världens nordligaste läkare. Medicinalväsendets första insteg i Nordskandinavien 1750-1810. Stockholm, Almqvist & Wiksell, 1979. Swedish.
- Sander BB, Rebolj M, Lynge E. Trends of cervical cancer in Greenland: a 60-year overview. Acta Oncol 2014;53(4):452-61.
- Sariola S. Lappi ja väkijuomat. Väkijuomakysymyksen tutkimussäätiö. Helsinki

- 1954:64-72. [Lapland and alcoholic beverage] Finnish.
- Savonen Severi. Tuberkuloositartunnan levinneisyydestä Suomessa. Thesis in University of Helsinki, Faculty of Medicine. 1937. Suomalaisen Kirjallisuuden Seuran kirjapaino. Helsinki 1937:160.
- Schaefer O. Medical observation and problems in the Canadian arctic, part III. CMAJ 1959;81:383-93.
- Schaefer O. Glucose tolerance testing in Canadian Eskimos: A preliminary report and a hypothesis. CMAJ 1968;99:252-262.
- Schaefer O, Hildes JA, Medd LM, Cameron DG. The changing pattern of neoplastic disease in Canadian Eskimos. . In: Shephard RJ, Itoh S. (eds.). Circumpolar Health 1974. Proceedings of the 3rd International Symposium on circumpolar health, Yellowknife, Canada. University of Toronto Press 1976:277-83.
- Schaefer O, Eaton RDP, Timmermans FJW, Hildes JA. Respiratory function impairment and cardiopulmonary consequences in long term residents of the Canadian Arctic. CMAJ 1980;123:997-1004.
- Schmorl G, Junghanns H. Die gesunde und die kranke Wirbelsäule in Röntgenbild und Klinik. G Thieme Verlag. Stuttgart 1968. German.
- Schreiner KE, Zur Osteologi der Lappen.I-II. Inst Sammeln Kulturforskn, Oslo 1931-1935.
- Schulz LO, Bennett PH, Ravussin E, Kidd JR, Kidd KK, Esparza J, Valencia ME. Effects of traditional and western environments on prevalence of type 2 diabetes in Pima Indians in Mexico and the U.S. Diabetes Care. 2006;29(8):1866-71.
- Scott EM, Griffith IV. Diabetes Mellitus in Eskimos. Metabolism 1957;6:320-5.
- Seitamo L. Psychological aspects on suicidality among the Skolt Lapps in Finland. Arct Med Res Rep 1980;27:110-13.
- Selmer-Olsen R. An odontometrical study on the Norwegian Lapps. In: J Dybvad (ed.) Skr N Vid Akad I :3. Oslo 1949.
- Selnes A, Nystad W, Bolle R, Lund E. Diverging prevalence trends of atopic disorders in Norwegian children. Results from three cross-sectional studies. Allergy 2005;60:894-9. [Cited 12 Dec 2012]. Available at: <http://onlinelibrary.wiley.com/doi/10.1111/j.1398-9995.2005.00797.x/full>
- Seppänen K. Does mercury promote lipid peroxidation? University of Kuopio. Publication C 177. 2004.University of Eastern Finland 2004.

- Seurujärvi-Kari I. (A) Saami Homeland. In: Kulonen UM, Seurujärvi-Kari I, Pulkkinen R. (eds.). *The Saami. A Cultural Encyclopaedia*. Suomalaisen Kirjallisuuden Seura. 2005:347.
- Seurujärvi-Kari I. (B) Saami Parliaments. In: Kulonen UM, Seurujärvi-Kari I, Pulkkinen R. (eds.). *The Saami. A Cultural Encyclopaedia*. Suomalaisen Kirjallisuuden Seura. 2005:350-4.
- Shanahan TL, Zeitzer JM, Czeisler CA. Resetting the melatonin rhythm with light in humans. *J Biol Rhythms*. 1997 Dec;12(6):556-67.
- Shui I, Giovannucci E. Vitamine D status and cancer incidence and mortality. *Adv Exp Med Biol* 2014;810:33-51.
- Sievers ML, Fisher JR. Diseases of North American Indians. In: Rothschild H, Chapman CF. *Biocultural Aspects of Disease*. (eds.). Academic Press 1981:229-230,
- Silman AJ, Pearson JE. Epidemiology and genetics of rheumatoid arthritis. *Arthritis Res* 2002;4(Suppl 3):S265-72 doi:10.1186/ar578.
- Silviken A, Haldorsen T, Kvermo S. Suicide among indigenous Sami in Arctic Norway, 1970-1998. *Eur J Epidemiol* 2006;21(9):707-13.
- Siuruainen E, Aikio P. The Lapps in Finland. The population, their livelihood and their culture. Society for the Promotion of Lapp Culture Series no 39. Helsinki 1977.Pp.60.
- Sjölander P, Daerga L, Edin-Liljegren A, Jacobsson L. Musculoskeletal symptoms and perceived work strain among reindeer herders in Sweden. *Occup Med (Lond)* 2008;58(8):572-9.
- Schlenzka D. Congenital dislocation of the hip. Finnish. *Duodecim*. 1991;107(7):500-7.
- Smith-Sivertsen T, Tchachtchine V, Lund E, Bykov V, Thomassen Y, Norseth T. Urinary Nickel excretion in populations living in the proximity of two Russian Nickel refineries: A Norwegian-Russian population based study. *Environ Health Perspect* 1998;106(8):503-11.
- Snedeker SM. Pesticides and breast cancer risk: a review of DDT, DDE and dieldrin. *Environ Health Perspect* 2001;109(Suppl 1):35-47.
- Soininen L. Speciella problem inom primärvården i Finska Lappland. Primärvård i glesbygd. Nordiska Ministerråd Oslo 1979;12:68-75.
- Soininen L. Pohjois-Lapin terveydenhuolto. [The health care system of the North-Lapland]. *Lapin Tutkimusseuran vuosikirja XXII* 1981:31-40.

Finnish.

- Soininen L, Lundén J. A mask saving warmth of breathing air. An appliance for cold climate. Harvald B, Hart Hansen JP. (eds.). Circumpolar health 81. Proceedings of 5th International Symposium on Circumpolar Health Copenhagen 9-13 August 1981. Nordic Council for Arctic Medical Research Report Series 33. Stougaard Jensen/ Copenhagen 1982:576-7.
- Soininen L, Åkerblom HK. Infant mortality in the Lapp areas of Finnish Lapland. In: Harvald B, Hart-Hansen JP. (eds.). Circumpolar Health 81. Proceedings of the 5th International Symposium on Circumpolar Health. Copenhagen 9-13 August 1981. Nordic Council for Arctic Medical Research Report Series 33. 1982:169-71.
- Soininen L. Puhelinlääkäri terveystieteiskeskuksesta. [The telephone-physician in the health centre]. Kunnallislääkäri. 1986;86:40-2. Finnish.
- Soininen L. Skin diseases of Finnish Lapps. Abstracts . 7th International Congress on Circumpolar Health June 8-12.1987 Umeå Sweden. Arct Med Res 1987;45:69.
- Soininen L. Pelastuspalvelu ja ensihoito kylmässä. [Rescue and first care in the cold]. Systole 1988;1:16-19. Finnish.
- Soininen L. Ilma-aluksilla suoritettut sairaankuljetukset 1989-1990 Lapin läänissä. Systole 1990;5:32-3. [The patient transport by air in Lapland in 1989-1990]. Finnish.
- Soininen L, Hantula L. Snowmobile accidents in Lapland. Arct Med Res 1992;51:Suppl 7:64-70.
- Soininen L. Fatal accidents in Finnish Lapland. Arctic Med Res 1994;53:448-50.
- Soininen L, Mussalo-Rauhamaa H, Kantola M, Seppänen K, Koivusalo M. Trends in the concentrations of mercury and selenium in inhabitants of north-eastern Finnish Lapland in 1982 – 1991. Sixth Conference of the International Society for Environmental Epidemiology Sept 18-21.1994. North Carolina, USA. Poster.
- Soininen L, Mussalo-Rauhamaa H, Hyvönen S. AMAP Human Health. Biomonitoring and studying the nutrition of mothers and newborn in the Finnish Lapland. Lapland Regional Environment Centre. Ministry of Environment 2005 Pp.108. ISBN 952-11-2000-2, ISSN 1238-8610. The Finnish version was published 2002. ISSN 0786-3489.
- Soininen L, Mussalo-Rauhamaa H, Hyvönen S. Urinary arsenic concentration

- of Lappish pregnant women and newborns. Do we need a follow up? The second AMAP International Symposium on Environmental pollution of the arctic. October 1-4. 2002, Rovaniemi, Finland. AMAP report 2002:2 (poster).
- Soininen L, Mussalo-Rauhamaa H, Lehto J. Hair Chromium concentration of Northern Finns. *Int. J Circumpolar Health* 2003;62(3):276-83.
- Statistics Canada 2013. Infant mortality. [Cited 4 Sept 2013] Available at: <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/health21a-eng.htm>
- Statistics Finland. Basis for an investigation of the cause of death. Available at: http://www.stat.fi/meta/kas/peruste_en.html (Cited Feb 2015)
- Statistics Finland 2005. The key between the short list in the time series of the causes of death since 1969 and the earlier classifications [Cited 18 Jan 2014] http://tilastokeskus.fi/til/ksyyt/2005/ksyyt_2005_2006-10-31_luo_002.html
- Statistics Finland 2010. Quality description of cause of death statistics. Official Statistics of Finland (OSF): Causes of death [e-publication]. ISSN=1799-5078. 2010, Quality description of cause of death statistics . Helsinki: Statistics Finland [cited: Nov 23rd 2014]. Access method: http://tilastokeskus.fi/til/ksyyt/2010/ksyyt_2010_2011-12-16_laa_001_en.html.
- Statistics Finland 2013. Laatuseloste: Kuolemansyyt 2013. Finnish. Available at: http://www.stat.fi/til/ksyyt/2013/ksyyt_2013_2014-12-30_laa_001_fi.html (Cited Feb 2015)
- Statistics Finland 2014. Suicides in Finland. http://pxweb2.stat.fi/Dialog/varval.asp?ma=090_ksyyt_tau_109&path=../database/StatFin/ter/ksyyt/&lang=3&multilang=fi
- Statistics Greenland. [Cited 4 Jan 2014]. Available at: <http://www.stat.gl/?lang=en>
<http://www.stat.gl/dialog/topmain.asp?lang=en&subject=Tobacco%20and%20alcohol&sc=AL>
- Steen A. Kautokeinoslekter. Samiske samlinger. Bind 1. Norsk Folkmuseum . Oslo 1952. Norwegian.
- Stenbäck F. Accuracy of antemortem diagnosis in the North. An autopsy study. *Arct Med Res Rep* 1986;41:9-15.
- Stepanova EG, Shubnikov EW. Diabetes, glucose tolerance and some risk factors

- of diabetes mellitus in Natives and newcomers on Chukotka. In: Postl BD, Gilbert P, Goodwill J, Moffat MEK, O'Neil JD, Sarsfield PA, Young TK. (eds.). *Circumpolar Health 90. Proceedings of the 8th International Congress on Circumpolar Health*. Whitehorse, Yukon, May 20-25, 1990. Canadian Society for Circumpolar Health. University of Manitoba Press Winnipeg, Manitoba 1991:413-4.
- Storm HH, Nielsen NH. Cancer of the digestive system in Circumpolar Inuit. *Acta Oncologica* 1996;35(5):553-70.
- Stutzman CD, Nelson DM, Lanier AP. Estimates of cancer incidence in Alaskan natives due to exposure to global radioactive fallout from atmospheric nuclear weapons testing. *Alaska Medicine* 1986;28(3):67-77.
- Sumari P, Partanen T, Hietala S, Heinonen OP. Blood and hair mercury content in fish consumers. A preliminary report. *Work-Environm-Hlth*. 1972;9:61-5.
- Sundberg S, Andersen KL. The maximal oxygen uptake in adult Lapps and Skolts. In: *Circumpolar Health 1974*. Schephard RJ, Itoh S. (eds.). *Proceedings of the 3rd International Symposium*. Yellowknife, NWT. Toronto 1976:425-32.
- Sundberg S, Luukka P, Andersen L, Eriksson AW, Siltanen P. Blood pressure in adult Lapps and Skolts. *Ann Clin Res* 1975;7:17-22.
- Tambets K, Rootsi S, Kivisild T, Help H, Serk P, Loogväli E-L, Tolk H-V, Reidla M, Metspalu E, Pliss L et al. The Western and Eastern Roots of the Saami-the Story of Genetic "Outliers" told by Mitochondrial DNA and Y Chromosomes. *The American Journal of Human Genetics* 2004;74(4):661-82. [Cited 2 Dec 2012]. Available at: [http://www.cell.com/AJHG/abstract/S0002-9297\(07\)61892-8](http://www.cell.com/AJHG/abstract/S0002-9297(07)61892-8) - aff1
- Tanner J. Antropogeografiska studier inom Petsamområdet i Skottlapparna. *Fennia* 1929;49(4):280-92.
- Taylor HR. The biological effects of UV-B on the eye. *Photochem Photobiol* 1989;50(4):489-92
- Teppo L, Pukkala E, Lehtonen M. Data quality and quality control of a population-based cancer registry. Experience in Finland. *Acta Oncol* 1994;33:365-9.
- Thelle DS, Forde OH. Cardiovascular study in Finnmark county - coronary

- risk-factors and the occurrence of myocardial-infarction in 1st degree relatives and in subjects of different ethnic-origin. *Am J Epidemiol* 1979;110(6):708-15.
- THL 2013. Alkoholijuomien kulutus. [The consumption of alcohol in 2013]. Finnish. Available at: <http://www.thl.fi/fi/tilastot/tilastot-aiheittain/paihteet-ja-riippuvuudet/alkoholi/alkoholijuomien-kulutus> (Cited 4 Feb 2015)
- THL 2014. Oikeuslääketieteellinen kuolemansyyn tutkiminen [Investigation of violent death]. In Finnish. Available at: <https://www.thl.fi/fi/palvelut-ja-asiointi/analyysi-ja-tutkimuspalvelut/oikeuslaakinta/kuolemansyyn-selvittamisjarjestelmat/oikeuslaaketieteellinen-kuolemansyyn-selvittaminen> (Cited 27th March 2015).
- THL 2014. Fineli. Vitamin D recommendations. [Cited 2 Aug 2013]. Available at: [20http://www.fineli.fi/component.php?compid=2271](http://www.fineli.fi/component.php?compid=2271)
- Thorslund J. Inuit suicides in Greenland. *Arct Med Res* 1990;49:25-33.
- Tiilikainen A, Eriksson AW, Macqueen M, Amos D B. The HL-A System in the Skolt Lapp population. Histocompatibility testing 1972. Munksgaard, Copenhagen, Denmark 1972:85-92.
- Timonen S, Franzas B, Wichman K. Photosensitivity of the human pituitary. *Ann Chir Gynaecol Fenn* 1964;53:165-72.
- Tikkanen E, Varmola M, Katermaa T. (eds.). Symposium on the State of the Environment and Environmental Monitoring in Northern Fennoscandia and Kola Peninsula. Arctic Centre 1992. October 6-8 1992 Rovaniemi, Finland. Extended abstracts. ISBN 951-634-288-4.
- Tomatis L. Editor in chief. Cancer: Causes, occurrence and control. WHO IARC Scientific publications. No 100. Lyon 1990. Pp.352.
- Toriola A. Epidemiological study of the role of vitamin D in the aetiology of ovarian cancer. Thesis. University of Tampere 2011. [Cited 8 Dec 2013]. Available at: <http://urn.fi/urn:isbn:978-951-44-8355-4>
- Toriola A, Sucrel H-M, Calypse A, Grankvist K, Luostarinen T, Lukanova A, Pukkala E, Lahtinen M. Independent and joint effects of serum 25-hydroxyvitamin D and calcium on ovarian cancer risk: A prospective nested case-control study. *Eur J Cancer* 2010;46;2799-2805.
- Tretli S, Bjartveit K, Foss OP, Haider T, Lund-Larsen PG. Intervention on cardiovascular-disease risk-factors in Finnmark county - changes after a period of 3 years - the cardiovascular-disease study in Finnmark county, Norway. *Scand J Soc Med* 1985;13(1):1-13

- Tuovinen J-P, Laurila T, Lättilä H, Ryaboshapko A, Brukhanov P, Korolev S. Impact of the sulphur dioxide sources in the Kola Peninsula on air quality in northernmost Europe. *Atmos Environ* 1993;27A:1379-95.
- Tverdal A. Cohort study of ethnic group and cardiovascular and total mortality over 15 years. *J Clin Epidemiol* 1997;6:719-23.
- Tynes T, Haldorsen T. Mortality in the Sami population of North Norway. *Scand J Publ Health* 2007, 35(3):306-12.
- UNSCEAR 1994. United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and effects of ionizing radiation: Report to the General Assembly, with Scientific Annexes. New York: United Nations 1994.
- Utsjoki. General information 2014. Available at: <http://www.utsjoki.fi/fi/yhteystiedot/kuntatietoa.php> Finnish, Sami. (Visited Nov 16th 2014)
- Valvira 2013. Kuolemansyyn selvittäminen. [Investigation of the cause of death]. In Finnish. (Cited 5th Jan 2015) Available at: http://www.valvira.fi/ohjaus_ja_valvonta/terveydenhuolto/kuolemansyyn_selvittaminen
- van Gijn J, Kerr RS, JE Rinkel GJE. Subarachnoid haemorrhage. *The Lancet* 2007;369(9558):306-18.
- Van Oostdam JC, Dewailly E, Gi A, Hansen JC, Odland JO, Chashchin V, Berner J, Butler-Walker J, Lagerkvist BJ, Olafsdottir K, Soininen L, Bjerregaard P, Klopov V, Weber JP. Circumpolar maternal blood contaminant survey, 1994 - 1997 organochlorine compounds. *Sci of the Total Environment* 2004;330:55-70.
- Vieltojärvi I-E. Enontekiöläisten leikki-ikäisten lasten äitien ruokatottumukset ja käsitykset ruoasta.. Opinnäytetutkielma. Ravitsemustieteen koulutusohjelma. Kliinisen ravitsemustieteen laitos. Kuopion yliopisto. Maaliskuu 1995. [Traditional food customs of the mothers in Enontekiö Sami district]. Finnish.
- Viitanen JK, Lehtinen K. Selkärankareuman diagnosointi ja hoito. [The diagnosing and care of ankylosing spondylitis]. 2000;55(42):4263-6. Finnish.
- Virokannas H, Anttonen H. Combined effects of cold, vibration and smoking, particularly in snowmobile users. *Arct Med Res* 1994;53(Suppl 3):29-34.
- von Bonsdorff C. Populationsgenetisk och demografisk översikt över Enare populationen före år 1870, med speciell hänsyn till genflödet från Finnarna till Samerna. Pro gradu arbete. Helsingfors Universitetet. Genetiska Institutionen. M Sci thesis. University of Helsinki. Institute of Genetics. 1971. Swedish.

- von Bonsdorff C, Fellman J, Lewin T: Demographic studies on the Inari Lapps in Finland with special reference to their genealogy. Nordic Council for Arctic Medical Research Report 1974;6:13-35.
- von Bonsdorff C, Fellman J, Lewin T: Demographic studies on the Inari Lapps in Finland. In: Shephard RJ, Itoh S. (eds.). Circumpolar Health 1974. Proceedings of the 3rd International Symposium on circumpolar health, Yellowknife, Canada. University of Toronto Press 1976:182-8.
- Wessel AB. Laaghalte slegter i Finnmarken. Tidskr Nor Legeför 1918;38:337. [The limping families in Finnmark]. Norwegian.
- Wiklund K, Holm LE, Eklund G. Cancer risks in Swedish Lapps who breed reindeer. Am J Epidemiol 1990;132(6):1078-82.
- Wiklund K, Holm LE, Eklund G. Mortality among Swedish reindeer breeding Lapps in 1961-1985. Arct Med Res 1991;50:3-7.
- Williams RC, Jacobsson LT, Knowler WC, del Puente A, Kostyu D, McAuley JE, Bennett PH, Pettit DH. Meta-analysis reveals association between most common class II haplotype in full-heritage Native Americans and rheumatoid arthritis. Hum Immunol 1995;42(1):90-4.
- Yliruokanen A. Terveysthuollon kehitys Lapin läänissä. Lapin Kansa Nov 22nd 1981. [The advancement of the health care of Lapland]. Finnish.
- Young KT. Epidemiology and control of chronic diseases in circumpolar Eskimo/Inuit populations. Arct Med Res 1986;42:25-47.
- Young KT, Moffat MK, O`Neil JD. An epidemiological perspective of injuries in the northwest territories Arct Med Res 1992;51:27-36.
- Young KT, Moffat MK, O`Neil J D. Cardiovascular diseases in a Canadian Arctic population. Am J Public Health 1993;83:881-7.
- Young KT. The Health of Native Americans. Toward a biocultural epidemiology. Oxford: Oxford University Press; 1994. 1,219 Pp.
- Young KT. Circumpolar Health Indicators: Sources, Data and Maps. Circumpolar Health Supplements 2008; 3:55-76
- Young KT. Circumpolar Inuit Cancer Review Working Group. Rapporteur: Young KT: Cancer among the circumpolar inuit, 1989-2003 I. Background and methods. Int J Circumpolar Health 2008;67(5):396-407.
- Young KT. Circumpolar Inuit Cancer Review Working Group. Rapporteur: Young KT: Cancer among the circumpolar inuit, 1989-2003 II. Patterns and trends. Int J Circumpolar Health 2008;67(5):408-20.
- Young KT. Infectious diseases [2011:1]. Int J Cicumpolar Health 2011;70(5):450-6.

- Åkerblom H. Infektionssjukdomarnas särdrag i nordliga glesbygder. Finska Läkaresällskapets Handlingar 1975;135(119):40-46. [Infectious diseases in northern areas]. Swedish.
- Ångström T. Johan Ångström, provinsialläkare och naturalhistoriker. Hälsa och hälsovård i södra Lappland 1853-68. Rondellen 2012; 32. URL: http://www.rondellen.net/health32_swe.htm
- Øygard K. General aspects of rhythm and sleep disturbances in Finnmark. Nordic Council Arct Med Res Rep.1974;10:15-6.

OTHER DATA SOURCES

Legislation concerning the Sami:

- 731/1999 Suomen perustuslaki. Available at: www.Finlex.fi [The Constitution of Finland]. Finnish.
- 253/1995 Kolttalaki. Available at: www.Finlex.fi. [Act on Skolt Sami] Finnish.
- 974/1995 Laki saamelaiskäräjistä 17.7.1995/974. Available at: www.Finlex.fi. [Act on the Sami Council]. Finnish
- 45/2000 Porotalouden ja luontaiselinkeinojen rahoituslaki. Available at: www.Finlex.fi [Act on financing and support of the reindeer herding and primary production]. Finnish.
- 1086/2003 Saamen kielilaki. Available at: www.Finlex.fi [Act on Sami language]. Finnish.
- 364/1963 Sairausvakuutuslaki. Available at: www.Finlex.fi. [Sickness insurance act] Finnish, old. New: 1224/2004
- 66/1972 Kansanterveyslaki. Available at: www.Finlex.fi [Public Health Act] Finnish.
- 459/1973 Laki kuolemansyyn selvittämisestä. Available at: www.Finlex.fi [Act on the Investigation of the Cause of Death] Finnish.
- 1326/2010 Terveystenhuoltolaki [Health care act] Finnish

Other information sources:

- IBP/HA, International Biological Program./ Human Adaptability. Interviews 1967-1971. Unpublished data.
- Kela Statistics 1960-1974. The Social Insurance Institution of Finland. Unpublished mortality statistics of municipalities Inari and Utsjoki.

- Sami Lahtinen. Innovations, Transport and Tourism. Statistics Finland. The number of snowmobiles and four wheels in Lapland. e-mail at 20th Sept 2014.
- Lindroth Saimi. Terveysisarena tunturipitäjässä. Porvoo 1970:147-9. [Working as public health nurse in a mountain parish]. Finnish.
- Louekari L. Pediatric investigations on the Skolts. Rep Nord Humanekol Symp Kopenhagen 1968.
- Pesonen A. Lentopelastuspalvelu Lapissa. Esitelmä Pelastuspalveluseminaarissa Ivalossa 26.10.1977. [Airplane rescue services in Lapland. Lecture in the rescue seminar Oct 26 1977]. Finnish.
- Sami parliament. Sami statistics 1999, 2003, 2007, 2011.
- Wallqvist E. Voiko tohtori tulla? Lääkärin kokemuksia Ruotsin Lapissa. WSOY 1945 9-55. [Can doctor come? Experiences of physician's work in Swedish Lapland]. Finnish.

10 ORIGINAL ARTICLES

11 APPENDICES

Appendix 1. Per cent of Sami in Inari and Utsjoki

The number of Sami and non-Sami in Inari and Utsjoki in 1750-2011

<u>Year</u>	<u>Inari</u>				<u>Utsjoki</u>			
	Sami	Non-Sami	Total population	Sami %	Sami	Non-Sami	Total population	Sami %
1750	323	-	323	100	191	-	191	100
1800	445	18	463	96	254	3	257	99
1850	458	179	637	72	325	4	329	99
1860	499	202	701	71	355			99
1900	799	585	1384	58	475	13	488	97
1910	999	976	1975	51	459	35	494	93
1920	806	930	1736	46	491	37	528	93
1930	840	1256	2096	40	608	10	618	98
1940	820	1907	2727	30	734	47	781	94
1948	1261	2778	4039	31	750	274	1024	73
1962	2213	4992	7205	31	1008	282	1290	78
1970	2172	4759	6853	31	1077	307	1350	77
1975	2173	4601	6774	32	1051	387	1438	73
1984	2096	5060	7156	29	1089	439	528	71
1999	2243	5209	7452	30	987	425	1412	70
2003	2152	5001	7153	30	821	564	1385	59
2007	2208	4746	6954	32	809	526	1335	61
2011	2137	4617	6754	32	768	526	1294	59

References:

1750-1930 Lapin komitean mietintö 1905
 1940 Helander 1991/ Siuruainen 1977
 1948 Saamelaisasiain komitean mietintö 1952
 1962 Nickul 1968
 1970 Finnish population census
 1975 Karjalainen 1979
 1984 Finnish population registry
 1999-2011 Sami Council

Appendix 2. Mercury

Concentrations of mercury in hair and blood of the people in Lapland and other Arctic areas

Mercury Hg	Sample type	No of samp-les	Year and place of sampling	Mean	Me-dian	Range	Reference	Remarks
mg/kg	Hair of inhabitants	11	1980 Lokka reservoir	7.3	0.6		Lodénus et al 1982	Biological half- life of Inorganic Hg 30-60 days Organic 60-160 days/ system
nmol/L blood (µg/L)	People with high fish consumption	1)	1982 Inari	107 (21.5)		55-220 (11-44)	Kirjarinta et al 1982	Hg in fish and human urine were 95% organic mercury
nmol/L blood (µg/L)	People with low fish consumption	1)	1982 Inari	35 (7.0)				Blood concentration 1-5 µg/L
mg/kg hair	People with high fish consumption	1)	1982 Inari	3.3		2.0-8.5	Kirjarinta et al 1982	Even people with low consumption of fish had 10 times higher values
mg/kg hair	People with low fish consumption	1)	1982 Inari	0.7		0.5-1.6		
mg/kg	Hair of inhabitants near Northern lakes	43	1980 Lapland	1.6		0.02-13	Lodénus et al 1982	
mg/kg	Females hair	6	1982 Inari	2.0	1.2	0.8-3.6	Mussalo-Rauhamaa et al 1996	
mg/kg	Males hair	5	1982 Inari	2.6	0.6	1.9-3.3		
mg/kg	Females hair	14	1991 Inari	1.6	1.6	0.2-6.2		
mg/kg	Males hair	11	1991 Inari	2.2	1.6	0.6-4.7		
nmol/L (µg/L).	Reindeer Herders blood	230	1989 Lapland	26 (5.2)		0-140	Luoma et al 1994	Positive correlation to fish eating. Highest in northeast Lapland
µg/L	Maternal Blood	130	1996-98 Finnish Lapland	1.6	1.4	0.2-6.0	Soininen et al 2002	Mercury pass the placenta and can cumulate to the foetus.
µg/L	Cord blood	113	1996-98 Finnish Lapland	2.3	1.8	0.4-8.2		Guideline 5-10mg/L blood
µg/L	Maternal blood Inuits	43	1994-5 Greenland	19.8	16.3		AMAP assessment 1998	10-20 µg/g in mothers hair can cause neurological disturbances in fetus,
µg/L	Cord blood	33	1994-5 Greenland	54.3				

µg/L	Maternal blood Inuits	198	1994-5 Nunavik Canada	17.2			Amap assessment 1998	Guidline of blood Hg 18 µg/L (90 nmol/L) (CEC 1993),
µg/L	Maternal blood	40	1994 Kirkenes Norway	3.4			Amap assessment 1998	WHO (IPCS 1991) 5-10 µg/L blood (25-50 nmol/L) without exposure of fish.
µg/L	Cord blood	20	1994 Norway	5.2	2.2			
µg/L	Maternal blood	23	1994-6 Sweden	1.6			Amap assessment 1998	

1) Not mentioned in the paper

Appendix 3. Chromium, lead, nickel, and arsenic

Chromium, lead, nickel, and arsenic in the Arctic people's blood, cord blood and urine.

Substance	Sample	N	Year and place of collection	Geometric mean	Median	Range	Reference
Chromium µg/g hair	Females hair	7	1982 Ivalo	0.11		0.09-0.15	Soininen et al 2003
Chromium µg/g hair	Males hair	5	1982 Ivalo	0.33		0.16-0.54	
Chromium µg/g hair	Females hair	7	1980s Helsinki	0.13		0.08-0.24	
Chromium µg/g hair	Males hair	16	1980s Helsinki	0.28		0.09-1.00	
Chromium µg/g hair	Females hair Sami and non-Sami	13	1991 Ivalo, Nellim, Sevettijärvi	0.18		0.09-0.45	
Chromium µg/g hair	Males hair Sami and non-Sami	12	1991 Ivalo, Nellim, Sevettijärvi	0.36		0.07-0.68	
Lead µg/L	Maternal blood	130	1996-98 Lapland	13.7	12.0		Soininen et al 2002
Lead µg/L	Maternal blood	40	1994 Norway	12.4			AMAP 1998 Assessment
Lead µg/L	Maternal blood Inuits		1994-95 Nunavik Canada	82.6			AMAP 1998 Ass
Lead µg/L	Cord blood	113	1996-98 Lapland	< DL	<DL		Soininen et al 2002
Lead µg/L	Cord blood		1994 Kirkenes Norway	12.4			AMAP report 1998
Lead µg/L	Cord Blood		1996 Nunavik Canada	40.6			AMAP ass 1998
Lead µg/L	Children under 7 y blood	35	1988 Helsinki Finland	29		21-83	Pönkä et al 1991
Lead µmol/L	Reindeer herders blood	230	1989 Lapland	0.22 A		0-0.90	Luoma et al 1994
Lead µmol/L	Maternal Blood	114	1993-1994 Nikel, Monche-gorsk, Archangel	0.14 A		0.04-0.7	Odland et al 1999
Lead µmol/L	Maternal Blood	148	1993-1994 Northern Norway	0.06 A		0.02-0.19	Odland et al 1999

Substance	Sample	N	Year Place of collection	Geo- metric mean	M	Range	Reference
Cadmium µg/L	Maternal Blood	130	1996-98 Lapland	0.19 A	0.10	0.1-2.2	Soininen et al 2002
Cadmium µg/L	Maternal blood	60	1994-6 Sweden	0.7 A			AMAP ass. 1998
Cadmium µg/L	Maternal blood		Canada	5.0 A			AMAP ass. 1998
Cadmium µg/L	Cord blood	93	1996-98 Lapland	0.14 A	0.10	0.1-1.8	Soininen et al 2002
Cadmium µg/L	Cord Blood		1994 -95 Canada	0.2 A			AMAP 1998
Cadmium µg/L	Cord blood	64	1994-6 Sweden	1.1 A			AMAP 1998
Cadmium nmol/L (µg/L)	Sami reindeer herders	230	1989 Lapland	10.0 A (1.1)		0-330 (0-37)	Näyhä et al 1991 Luoma et al 1994
Cadmium nmol/L	Maternal blood	148	1999 Russia	2.2 M		0.5-35.2	Odland et al 1999
Cadmium nmol/L	maternal blood	114	1999 Norway	1.8 M		0.5-26.9	
Nickel µg/L	Maternal Blood	79	1996-98 Lapland	0.61 A	0.50	0.5-3.0	Soininen et al 2002
Nickel µg/L	Cord blood	71	1996-98 Lapland	1.47 A	1.14	0.5-3.0	Soininen et al 2002
Nickel µg/L	Maternal Urine	79	1996-98 Lapland	0.85 A	0.68	0.2-3.6	Soininen et al 2002
Nickel µg/L	Newborn Urine	71	1996-98 Lapland	1.47 A	1.14	0.5-3.0	Soininen et al 2002
Nickel µg/L	adult population urine		Nikel 1995	4.9	3.4	0.3-61.9	Smith-Sivertsen et al 1998
Nickel µg/L	adult population urine		Umba 1996	4.0	2.7	1.0-17.0	Smith-Sivertsen et al 1998
Nickel µg/L	adult population urine		Sor-Varanger 1995	0.9	0.6	0.3-11.0	Smith-Sivertsen et al 1998
Arsenic µg/L	Maternal Blood	145	1996-98 Lapland	14.63 A	3.50	3.5-275	Soininen et al 2002
Arsenic µg/L	Cord blood	112	1996-98 Lapland	3.98 A	3.50	3.5-18	Soininen et al 2002
Arsenic µg/L	Maternal Urine	78	1996-98 Lapland	13.93 A	7.75	1.3-76.3	Soininen et al 2002
Arsenic µg/L	Newborn Urine	70	1996-98 Lapland	10.33 A	7.96	2.4-70.0	Soininen et al 2002

<DL = Below detection limit, 10 µg/L. A= arithmetic mean M=median value

APPENDIX 4. COPPER, ZINC AND SELENIUM.

Trace elements copper, zinc and selenium in hair, blood and serum of people in Lapland and other arctic areas

Substance	Target group	No of samples	Year of sampling	Mean	SD	Range	Reference
Copper mg/kg	Male hair Inari	5	1982	45	37	19-108	Mussalo-Rauhamaa et al 1996
Copper	Female hair Inari	6	1982	54	76	10-207	
Copper	Male hair Inari	11	1991	28	16	10-60	
Copper	Female hair Inari	14	1991	41	44	10-175	
Zinc mg/kg	Male hair	5	1982	137	25	108-164	Mussalo-Rauhamaa et al 1996
Zinc mg/kg	Female hair	6	1982	161	12	146-178	
Zinc mg/kg	Male hair	11	1991	138	34	74-179	
Zinc mg/kg	Female hair	14	1991	157	16	10-193	
Selenium µg/L	Serum female Inari	6	1982	88	24	77-116	Mussalo-Rauhamaa et al 1996
Selenium µg/L	Serum male Inari	5	1982	100	15	73-112	
Selenium µg/L	Serum female Inari	14	1991	134	42	64-202	
Selenium µg/L	Serum males Inari	11	1991	126	26	73-172	
Selenium µg/L	Maternal serum Lapland	145	1996-8	75			Soininen et al 2002
Selenium µg/L	Maternal serum Sweden			52			AMAP/HH Sweden
Selenium µg/L	Maternal serum NW Russia	76	1993	134		±15	AMAP Assessment Russia
Selenium µg/L	Cord blood serum Lapland	112	1996-8	55			AMAP/HH Finland
Selenium µg/L	Cord blood serum Sweden	147	1994-6	45	63	±15	AMAP Assessment Sweden
Selenium µg/L	Cord blood serum Greenland	43	1994-5	318	64,3	±13.4	AMAP assessment Greenland
Selenium µmol/L (µg/L)	Reindeer herders Finland	214	1989	1.56 (123)			Luoma et al 1995

APPENDIX 5. CANCER OF SAMI MEN.

Observed (Obs) and expected (Exp) numbers of cancer cases and standardized incidence ratios (SIR) with 95% confidence intervals (CI) among the Sami **males** with 75–100% of Sami ethnicity 1979–1998, 1999–2010 and 1979–2010 by site. Standard population is Finnish population (1.00).

Site	Sami MALES				
ICD 10 codes	Time period	Obs	Exp	SIR	95% CI
0 All	1979-1998	57	97	0.59	0.44-0.76
C00-C48	1999-2010	49	72	0.68	0.51-0.90
	1979-2010	106	169	0.63	0.51-0.75
Mouth, pharynx, lip	1979-1998	2	2.7	0.74	0.09-2.68
C00-C14	1999-2010	3	1.6	1.90	0.39-5.55
	1979-2010	5	4.3	1.17	0.38-2.73
Stomach	1979-1998	7	6.6	1.06	0.43-2.19
C16	1999-2010	2	2.2	0.90	0.11-3.24
	1979-2010	9	8.8	1.02	0.47-1.94
Colon	1979-1998	2	4.7	0.43	0.05-1.54
C18-C19	1999-2010	3	3.9	0.8	0.16-2.25
	1979-2010	5	8.6	0.58	0.19-1.35
Rectum	1979-1998	3	3.9	0.76	0.16-2.23
C20-C21	1999-2010	2	2.9	0.69	0.08-2.51
	1979-2010	5	6.8	0.73	0.24-1.70
Liver	1979-1998	1	1.4	0.70	0.02-3.90
C22	1999-2010	0	1.2	0.00	0.00-2.97
	1979-2010	1	2.7	0.37	0.01-2.08
Gallbladder	1979-1998	1	0.9	1.10	0.03-6.12
C23-C24	1999-2010	2	0.5	4.08	0.49-14.7
	1979-2010	3	1.4	2.13	0.44-6.22
Pancreas	1979-1999	1	3.6	0.28	0.01-1.55
C25	1999-2010	1	2.4	0.41	0.01-2.29
	1979-2010	2	6.0	0.33	0.04-1.20
Other digestive organs	1979-1998	4	0.37	10.8	2.95-27.7
C26	1999-2010	1	0.18	5.56	0.14-31.0
	1979-2010	5	0.6	9.05	2.94-21.1
Lung	1979-1998	18	20.2	0.89	0.53-1.41
C32-C34	1999-2010	8	9.0	0.89	0.38-1.75
	1979-2010	26	29.2	0.89	0.58-1.30
Prostate	1979-1998	5	19.7	0.25	0.08-0.59
C61	1999-2010	9	23.7	0.38	0.17-0.72
	1979-2010	14	43.4	0.32	0.18-0.54
Testis	1979-1998	0	0.55	0.00	0.00-6.71
C62	1999-2010	1	0.33	6.06	0.73-21.9
	1979-2010	1	0.88	1.14	0.03-6.34
Kidney	1979-1998	1	3.6	0.28	0.01-1.56
C64	1999-2010	2	2.4	0.82	0.10-2.97
	1979-2010	3	6.0	0.50	0.10-1.46
Bladder, ureter, urethra	1979-1998	1	5.7	0.18	0.004-0.98

C66-C67	1999-2010	1	3.6	0.28	0.01-1.57
	1979-2010	2	9.22	0.22	0.03-0.78
Brain	1979-1998	4	2.5	1.59	0.43-4.06
C71	1999-2010	2	1.8	1.10	0.13-3.97
	1979-2010	6	4.35	1.38	0.51-3.00
Thyroid gland	1979-1998	0	0.57	0.00	0.00-6.47
C73	1999-2010	1	0.43	2.33	0.06-13.0
	1979-2010	1	1.01	0.99	0.03-5.52
Lymphoid. haematop. tissue	1979-1998	1	7.9	0.13	0.003-0.71
C81-C96	1999-2010	8	5.5	1.5	0.63-2.87
	1979-2010	9	13.4	0.7	0.31-1.28
Hodgkin lymphoma	1979-1998	0	0.66	0.00	0.00-5.59
C81	1999-2010	0	0.26	0.00	0.00-14.2
	1979-2010	0	0.93	0.00	0.00-3.97
Non-Hodgkin lymphoma	1979-1998	1	3.2	0.32	0.01-1.76
C83	1999-2010	3	1.3	2.40	0.49-7.00
	1979-2010	5	5.9	0.84	0.40-3.74
Nodal non-Hodgkin lymphoma	1979-1998	1	2.14	0.47	0.01-2.60
C82	1999-2010	2	1.53	1.31	0.16-4.72
	1979-2010	3	3.67	0.82	0.17-2.38
Multiple myeloma	1979-1998	0	1.35	0.00	0.00-2.73
C90	1999-2010	2	0.9	2.25	0.27-8.12
	1979-2010	2	2.2	0.91	0.11-3.28
Melanoma of the skin	1979-1998	1	2.27	0.44	0.01-2.45
C43	1999-2010	0	2.32	0.00	0.00-1.59
	1979-2010	1	4.60	0.22	0.01-1.21
Skin non-melanoma	1979-1998	0	2.96	0.00	0.00-1.25
C44	1999-2010	0	3.07	0.00	0.00-1.20
	1979-2010	0	6.03	0.00	0.00-0.61

APPENDIX 6. STANDARDIZED INCIDENCE RATIOS (SIR) OF SAMI WOMEN.

Observed (Obs) and expected (Exp) numbers of cancer cases and standardized incidence ratios (SIR) with 95% confidence intervals (CI) among the Sami **females** with 75–100% of Sami ethnicity in two time periods 1979-1998 and 1999-2010 and the total time period 1979-2010. The standard population is the Finnish population (1.00).

Site		Sami FEMALES			
ICD 10	Time period	Obs	Exp	SIR	95% CI
0 All	1979-1998	52	74.0	0.70	0.53-0.92
C00-C48					
	1999-2010	49	57.2	0.86	0.63-1.13
	1979-2010	101	131.2	0.77	0.63-0.92
Lip, Mouth, pharynx	1979-1998	1	1.1	0.88	0.02-4.93
C00-C14	1999-2010	2	0.86	2.33	0.28-8.40
	1979-2010	3	1.99	1.51	0.31-4.40
Oesophagus	1979-1998	0	0.9	0.00	0.00-4.19
C15	1999-2010	1	0.4	2.63	0.07-14.7
	1979-2010	1	1.26	0.80	0.02-4.430
Stomach	1979-1998	5	4.1	1.21	0.39-2.83
C16	1999-2010	1	1.5	0.67	0.02-3.74
	1979-2010	6	5.6	1.07	0.39-2.32
Colon	1979-1998	4	4.8	0.83	0.23-2.13
C18-C19	1999-2010	6	3.7	1.63	0.60-3.54
	1979-2010	10	8.5	1.18	0.57-2.16
Rectum	1979-1998	1	2.8	0.36	0.01-1.99
C20-C21	1999-2010	2	2.0	1.11	0.14-4.01
	1979-2010	3	4.80	0.62	0.13-1.82
Liver	1979-1998	0	0.86	0.00	0.00-4.29
C22	1999-2010	2	0.65	3.1	0.37-11.1
	1979-2010	2	1.5	1.32	0.16-4.77
Gallbladder	1979-1998	1	1.7	0.61	0.02-3.38
C23-C24	1999-2010	0	0.8	0.00	0.00-4.79
	1979-2010	1	2.41	0.41	0.01-2.30
Pancreas	1979-1999	4	3.1	1.29	0.35-3.30
C25	1999-2010	4	2.3	1.75	0.48-4.49
	1979-2010	8	5.36	1.49	0.64-2.94
Other digestive organs	1979-1998	4	0.40	10.0	2.72-25.6
C26	1999-2010	1	0.25	4.00	0.10-22.3
	1979-2010	5	0.7	7.65	2.48-17.85
Lung	1979-1998	4	3.2	1.25	0.34-3.20
C32-C34	1999-2010	2	2.9	0.69	0.08-2.49
	1979-2010	6	6.1	0.98	0.36-2.13
Breast	1979-1998	7	18.8	0.37	0.15-0.77
C50	1999-2010	7	17.6	0.40	0.16-0.82
	1979-2010	14	36.4	0.38	0.21-0.64
Cervix uteri	1979-1998	1	1.33	0.95	0.02-4.19
C53	1999-2010	3	0.69	4.29	0.88-12.5

	1979-2010	4	2.01	1.99	0.54-5.09
Corpus uteri	1979-1998	1	4.4	0.23	0.01-1.27
C54-C55	1999-2010	4	3.4	1.18	0.32-3.01
	1979-2010	5	7.7	0.65	0.21-1.51
Ovary	1979-1998	6	3.3	1.82	0.67-3.96
C56	1999-2010	3	2.0	1.47	0.30-4.30
	1979-2010	9	5.3	1.69	0.77-3.21
Kidney	1979-1998	2	2.2	0.90	0.11-3.25
C64	1999-2010	0	1.6	0.00	0.00-2.25
	1979-2010	2	3.8	0.52	0.06-1.87
Bladder, ureter, urethra	1979-1998	1	1.4	0.74	0.02-4.13
C67	1999-2010	1	0.9	1.1	0.03-5.93
	1979-2010	2	2.3	0.87	0.11-3.13
Brain	1979-1998	3	2.9	1.04	0.22-3.04
C71	1999-2010	2	2.4	0.84	0.10-3.02
	1979-2010	5	5.3	0.95	0.31-2.20
Thyroid gland	1979-1998	1	1.7	0.58	0.02-3.24
C73	1999-2010	1	1.1	0.89	0.02-4.93
	1979-2010	2	2.85	0.70	0.09-2.53
Lymphoid, haematopoietic tissue C81-C93	1979-1998	5	6.0	0.84	0.27-1.95
	1999-2010	3	4.2	0.72	0.15-2.10
	1979-2010	8	10.2	0.79	0.34-1.55
Hodgkin lymphoma	1979-1998	0	0.42	0.00	0.00-8.78
C81	1999-2010	0	0.16	0.00	0.00-23.1
	1979-2010	0	0.58	0.00	0.00-6.35
Non-Hodgkin lymphoma	1979-1998	2	2.6	0.77	0.09-2.79
C83	1999-2010	2	2.2	0.91	0.11-3.27
	1979-2010	4	4.8	0.83	0.23-2.13
Nodal non-Hodgkin lymphoma C82	1979-1998	1	1.7	0.58	0.01-3.20
	1999-2010	1	1.2	0.81	0.02-4.49
	1979-2010	2	3.0	0.67	0.08-2.40
Multiple myeloma	1979-1998	1	0.20	3.37	0.09-18.77
C90	1999-2010	0	0.9	2.25	0.27-8.12
	1979-2010	1	1.91	0.52	0.01-2.91
Melanoma of the skin	1979-1998	1	1.9	0.53	0.13-2.95
C43	1999-2010	0	1.8	0.00	0.00-2.00
	1979-2010	1	3.7	0.27	0.01-1.49
Skin. non-melanoma	1979-1998	0	2.37	0.00	0.00-1.56
C44	1999-2010	1	2.5	0.39	0.01-2.19
	1979-2010	1	4.9	0.20	0.01-1.13

